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VOLUME XII

SYPHILIS TO *TYPHUS FEVER*

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HISTORICAL.—The history of syphilis has been investigated more thoroughly than that of any other affection. Its earlier records are obscure, and for all practical purposes it appeared as a new disease in Europe in 1494, though it had long been recognised in the New World, and there is but little doubt that the Spaniards who sailed with Columbus in his first voyage became infected, and thus introduced it into the Old World at a most convenient opportunity for its wide distribution. Vigo (1460-1517?), writing as a contemporary, says: "In the month of December, when Charles the French King took his journey into the parts of Italy to recover the kingdom of Naples, there appeared a certain disease throughout all Italy of an unknown character, which sundry nations hath called by sundry names. The Frenchmen call it the disease of Naples, because the soldiers brought it from thence into France. The Neapolitans call it the French disease, for it appeared first when they came to Naples." In the end it became known as Morbus Gallicus, which the common people shortened to Morbus. In its first appearance it was epidemic, and as neither the mode of infection nor the method of cure was recognised, it spread with such rapidity that on the 21st April 1497 the Town Council of Aberdeen issued the following order: "The said day it was statut and ordanit be the Alderman and Consale (Council) for the eschewin of the infirmitey cumm out of Franche and strange partis, that all licht wemen be chargit and ordanit to decist fra thar vices and syne of venerie and all thar buthes and housis skalit, and thai to pass and wirk for thar sustentacioun, under the payne of ane key of het yrne one thair cheekis and banysene of the toune." Mr. Alexander Duncan, who quotes this edict, points out that it has an interest apart from its being the earliest notice of the presence of syphilis in Scotland, because before 1500 no medical writer on the subject had even hinted that it had any connection with the "syne of venerie." Yet, here in this northern Scottish burgh, the astute municipal authorities had anticipated conclusions subsequently come to by the faculty. In Scotland, too, syphilis was known as "Glengore" or "Granggore," a word corrupted from the French Grandgore, *à la grande gorre,* the local name for the disease at Rouen, as we learn from Rabelais (*Pantagruel,* v. xxi.). Six months after the Aberdeen edict the Scottish Privy Council issued the "Grangore Act," which ordered all the inhabitants of Edinburgh affected with the disease to pass out of the town and to appear upon the sands of Leith on a stated day and hour, thence to be conveyed by boat to the island of Inchkeith. The earliest entry referring to the disease in Glasgow occurs in the accounts of the Lord High Treasurer of Scotland (1497-98), where the following payment was made by the King (James IV.): "*Item,* the xxii day of Februar giffen to the seke folk in the grangore at the toun end of Glasgo . . . ii sol."

The now familiar name of Syphilis was given to the disease, or at any rate was rendered familiar, by the widely read poem *Syphilis, sive Morbus Gallicus,* written by Jerome Fracastoro, who was born at Verona about 1483.[1] It is remarkable that partly owing to the existence of a different canon of morality, and partly to the fact that at first syphilis was contracted extra-genitally in many cases, no great moral turpitude attached to the disease; thus Benvenuto Cellini, the Florentine goldsmith (1500-1570), says that "in Rome this kind of illness is very partial to the priests, and especially the richest of them." He tells us that it was treated in the native American manner with guaiacum, and that the methods of fumigation and inunction with mercury were originally employed at Rome by Giacomo

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[1] The first mention of the word occurs in the following lines:—

Syphilus (ut fama est) ipsa haec ad flumina pastor
Mille boves, niveas mille haec per pabula regi
Alcithoo pascebat oves.

(The story runs that Syphilus, a herdsman, tended by these streams a thousand oxen, and in these meads fed a thousand snow-white sheep, all belonging to King Alcithous.)

Berengario da Carpi. The first outbreak was very severe, as is usual when a disease attacks an unprotected population, but the symptoms became milder when it had lasted a few years, though there were occasional outbreaks of a more severe type.

Distribution.—No country and no people are exempt from syphilis. It is most common where opportunities for promiscuous intercourse are most abundant or are most readily tolerated, as in large towns and where the pioneers of a more highly civilised race are brought into contact with people in a lower state of culture. It is rarely seen in the country districts of Europe, where each knows his neighbour, for, with ordinary precautions, infection is always due to direct contact, so that any syphilitic individual has only a limited power of spreading the disease.

The more benign forms of syphilis are seen in those leading healthy lives, whilst its worst ravages occur in those whose health is undermined by alcoholic excess, sexual debauchery, or unhealthy surroundings. And yet, though this is the rule, there is no question that certain people are much more severely affected by syphilis than others, for in this as in every other disease the susceptibility of the individual patient must be taken into account.

General Pathology.—The general character of syphilitic manifestations is that of a chronic inflammation, which in its more pure forms shows but little tendency to suppurate. The cause of the disease is still unknown. Many observers have described various micro-organisms which they have believed to be specific, but it has not yet been found possible to produce the disease either by inoculation with these organisms or by the toxins which they manufacture. It is remarkable, too, that syphilis cannot be inoculated upon animals, even the higher primates, yet no human being appears to be immune, from earliest infancy to extreme old age, unless he has been protected by a previous attack.

Syphilis consists microscopically of numbers of small, round cells, some of which are derived from the connective tissue, whilst others are immigrant leucocytes. These cellular infiltrations show a singular tendency to undergo resolution in the earlier stages of the disease; whilst in the secondary and tertiary stages they develop into a low form of fibrous tissue-scar or fibroid tissue—or the individual cells may coalesce to form giant cells, whilst others undergo fatty and hyaline change. This infiltration of round cells is especially liable to occur in the perivascular lymphatics and in the neuroglia of the central nervous system. The syphilitic poison bears a direct relation to these cells in some way which is not yet known, though it is probable that they manufacture it when an infinitesimal amount has once been introduced into an unprotected body.

The characteristic inflammation of the later stages of syphilis is known as a gumma, the word being derived apparently from a simile adopted by Fracastoro in his poem on Syphilis when he wrote *mox in lentum durescere gummi.* The gumma in its typical form is a whitish or yellowish-white globular mass, which varies in size from a small pea to a walnut as it is seen with the naked eye. It is often circumscribed, but never encapsuled; it may invade the neighbouring tissues, and is surrounded by an inflamed zone, though no vessels penetrate the gumma itself. The tissue is sometimes tough and leathery in consistence, at other times it is soft and pulpy. It grows with varying rapidity, and with all the symptoms of an inflammatory swelling. Like all other syphilitic lesions a gumma may disappear completely, but when it suppurates and can discharge on the surface of the body, it leaves a perfectly circular, crater-like ulcer with a sloughy base and an undermined edge. In these cases repair is slow,—unless anti-syphilitic remedies are given,—and a depressed scar is produced.

MODES OF INFECTION.—The primary syphilitic lesion, whether it be a hard sore or merely an erosion, is acutely contagious; in the secondary stage syphilitic lesions of the skin and mucous membranes are very infectious, the mucous patches and condylomata seeming to be more liable to spread the disease than the papules and tubercles. Both in the primary and secondary stages the blood is capable of transmitting syphilis, and the lymph seems to have a similar power, though its action in this respect is less certainly known. It is not known either whether the tertiary manifestations of the disease are infective, though it seems probable that the earlier lesions are dangerous, whilst the later ones are inert. Infants with syphilis, whilst they have mucous patches and condylomata, are as capable of infecting others as those who have acquired the disease later in life, but infants with hereditary syphilis seem to be less capable of transmitting the disease than those who have acquired the disease just after birth. So far as is known at present, the syphilitic poison can only be inoculated by the transference of diseased cells or the débris of cells from the affected person to an abraded surface on the recipient, and the inoculation of a fluid free from cells or containing only healthy cells is insufficient to produce the disease. The urine, milk, and sweat, therefore, are innocuous unless the glands from which they are derived are actually syphilitic, but the saliva may transmit the disease, because the mouth is so often the seat of mucous patches. This statement, however, finds an exception in the semen, which may be inoculated with impunity, though it has the power of transmitting syphilis to the ovum it fertilises.

Syphilis can only be caused by inoculation with the syphilitic poison obtained from a pre-existing case of syphilis, but the poison is of great potency, and has some power of withstanding external influences. It is usually acquired during sexual intercourse, and the seat of inoculation therefore in about 90 per cent of the cases is at, or near, the genital organs. Indeed, the overwhelming proportion of cases of syphilis due to venereal infection has somewhat masked the fact that syphilis from a pathological standpoint is a chronic infective granuloma starting from a local lesion, the disease being one which in all probability must be classed between leprosy and cancer.

Inoculation with the syphilitic virus at any point is always successful in an unprotected person, and may lead to the disease in all its forms. It is not uncommon, therefore, for persons to contract syphilis accidentally and without venereal intercourse. Syphilis obtained in this manner is sometimes called "Syphilis insontium" or "Syphilis of the innocent," a thoroughly unscientific expression, for ethics have no place in pathology. Women, from their habit of kissing babies and casual acquaintances; surgeons, accoucheurs and midwives, from the nature of their occupation, are specially liable to contract syphilis. Certain occupations have been fruitful in the spread of syphilis, notably glass-blowing, where the blowing-tube is passed from mouth to mouth. Outbreaks of syphilis have been traced to arm-to-arm vaccination, and some years ago I saw several Jewish children who had been inoculated during the performance of ritual circumcision.

Dr. Bulkley, who has paid special attention to these unusual sources of infection, states that in extra-venereal syphilis, chancres of the lip are much the most numerous, the principal cause for the sore in this situation being kissing. Chancres of the breast and nipple, which come next in frequency, are becoming relatively rare, as the danger from syphilitic nurslings is better known and appreciated. It is interesting, too, to note that in the reports of 9058 cases of extra-genital chancres, collected by Dr. Bulkley, 571 cases occurred on the tonsils, in addition to 734 cases where the primary lesion was said vaguely to have been "in the buccal cavity," whilst 199 occurred on the tongue and gums, making no less than 1504 cases of primary syphilis within the cavity of the mouth. These statistics show that it is often worth while to inquire about the history of a sore mouth in the numerous cases where it is not found possible to elicit any recollection of venereal trouble.

The resistance of the syphilitic poison to external influences is shown by the fact that there are many authentic instances of the disease being communicated by contaminated pipes, cups, spoons, forks, towels, sponges, and articles of underclothing, as well as by unclean surgical and dental instruments, and by razors. The risk of infection with syphilis is so real, and people affected with the disease are so careless and so ignorant (for they often believe that they can only infect by sexual intercourse), that every individual should be warned of his liability to spread the disease, and should be definitely instructed in the precautions necessary to prevent him from so doing.

CLASSIFICATION.—Syphilis is either acquired or inherited. Acquired syphilis is always due to direct inoculation, the seat of inoculation being marked by a local inflammation known as a sore or chancre. Hereditary syphilis is divided somewhat academically into "congenital syphilis," where the infant is infected with syphilis contracted by the mother during pregnancy; and "inherited syphilis," where the disease begins at the time of conception, either from a syphilitic ovum or from contaminated spermatozoa.

ACQUIRED SYPHILIS

In acquired syphilis there is a definite inoculation followed by a period of incubation before the appearance of the first sign of the disease. This sign, the primary sore, which runs a definite course, if it be protected from injury, is followed by certain additional signs which constitute the stage of secondary syphilis. The secondary symptoms always follow inoculation with syphilis, though they may be readily overlooked in slight cases, and they usually, but not always under appropriate treatment, give place to a further sequence of chronic inflammatory changes which together make up the tertiary stage of the disease. This division of syphilis into primary, secondary, and tertiary stages was first adopted by Philippe Ricord (1800-1889). It is convenient for descriptive and therapeutic purposes, but it has no claim to scientific accuracy, and it is not clinically correct, for, as in all other infective diseases, the signs and symptoms of the various stages are often coexistent, and thus blend insensibly one with another.

Inoculation.—The inoculation of syphilis, so far as is known at present, can only take place upon a surface deprived of its surface epithelium in such a manner as to expose the intra-epithelial lymphatic system.

When the culture is pure the abrasion heals readily, and for some time there is nothing to alarm the patient or make him suspect that he has contracted so far-reaching a disease. More frequently, however, the inoculation has been a mixed culture containing various pyogenic organisms (see article VENEREAL DISEASE), and the abrasion becomes an ulcer.

Primary Syphilis.—Inoculation is followed by an incubation period of varying duration, which ends in the first local manifestation of syphilis or the primary sore. Countless observations have been made as to the duration of this incubation period, partly by clinical observation and partly by the experimental inoculation of syphilitic poison. The mean of these observations, so far as they have been tabulated, gives twenty-five days as the incubation period. This mean, however, is insufficient for practical purposes, and I am in the habit of telling my patients that they must not consider themselves safe until after the expiration of forty days from the date of exposure to infection.

The initial manifestation of syphilis varies greatly in appearance. It may be a mere erosion of the surface, it may be a dry papule, or it may be a chancre with an indurated base as in the classical form described by John Hunter, but more often so slightly indurated that it requires some skill as well as experience to distinguish it from a soft sore.

The initial manifestation of syphilis is usually single, but too much importance must not be laid upon this point in distinguishing syphilis from other forms of venereal disease, because syphilis may be inoculated simultaneously, either at two or more adjacent parts or at several places in the same body widely separated from each other.

The situation of the venereal chancre in the male is usually on the inner side of the foreskin or in the sulcus of the glans penis. The frænum, the orifice of the foreskin when the prepuce is long and tight, the glans and the meatus as well as the skin of the penis, are often the seat of the sore, whilst the scrotum and anus are not exempt. Chancres of the urethra occur either in the fossa navicularis or at some little distance from the meatus. They are important because the patient may be ignorant of their existence, and attribute his discomfort to an attack of gonorrhœa.

The female genitals are said to be liable to infection in the following order: the labia majora, the labia minora, the fourchette, the cervix uteri, the region of the clitoris, the vestibule of the vagina, the urinary meatus, the upper commissure of the vulva and the vagina. The induration is usually less marked in women than in men, and the initial lesion is often so slight that it passes unnoticed or is looked upon as a simple erosion.

The primary sore disappears spontaneously in syphilis, if it be kept clean and free from injury. Its duration, however, varies greatly, though it has usually disappeared by the time the secondary symptoms have become well marked.

Pathology of the Sore.—The first indication of syphilis is commonly a superficial erosion situated on the internal surface of the prepuce in men, and on the inner side of the labia minora in women. The erosion begins as a dry and slightly raised reddish spot, which soon begins to desquamate but is not painful. The spot is circular at first, but it soon becomes irregular owing to ulceration. The surface of the ulcer is bright coloured, smooth and flat, or very slightly excavated. The discharge is serous and scanty if the ulcer is protected, but it becomes purulent even if it be only slightly irritated. The induration is slight and superficial. Cicatrisation is rapid, and a slightly indurated scar is left, which eventually disappears entirely.

The Hunterian chancre or classical "hard sore" first appears as an indurated nodule, the surface of which soon ulcerates as a result of irritation. The edges of the chancre are raised and rounded, and the surface is smooth and covered with a little viscid secretion. In a typical case, when the nodule is pinched up between the finger and thumb, it feels as hard and inelastic as a mass of cartilage; often, however, the induration is more extensive but less well defined, and the lesion is then called the parchment sore. The hard sore is seen most often in the coronary sulcus of the penis near the frænum, and on the labia majora in women: the parchment sore is more common on the skin of the penis, and in the vulva. Little by little granulations appear, and the sore heals by cicatrisation to form a scar which is often pigmented, or it may remain as a fibrous nodule perceptible for many years.

The mixed chancre is one in which syphilis has been acquired at the same time as a soft sore (see art. Venereal Disease), and it is by no means an infrequent lesion. The soft sore runs its usual course as an ulcer, secreting pus until about the third week, when the ulcer begins to look less deep, whilst the secretion diminishes in quantity and becomes thinner and more viscid. The floor of the ulcer loses its irregular appearance and becomes flatter, whilst the edges are no longer undermined. This lessening in the depth and circumference of the ulcer is due to the development of an induration beneath it and around it, for such a sore can readily be raised from the underlying tissue, and feels of gristly hardness if it be pinched up between the finger and thumb. If the ulcer be kept clean its surface becomes smooth and glistening, the discharge gradually diminishes, and scarring takes place, often without any diminution of the induration. The induration usually disappears after a longer or shorter period, but it may persist owing to the conversion of the inflammatory tissue into scar tissue.

The indurated or sclerotic œdema is a rarer form of initial lesion, which is found in women on the labium majus, and in men as an infecting balanitis. The condition is due to a slow and painless swelling of the part involved until the labium or the prepuce is uniformly thickened and indurated.

The dry scaling papule is another rare form of primary lesion which has been most often seen as a result of experimental inoculation with syphilis when care has been taken to keep the part free from irritation. A sharply defined papule appears at the seat of inoculation at the end of the incubation period. It is dark or reddish brown in colour, round or oval in shape, and elastic in consistence. The induration is slight, it does not ulcerate, and gradually subsides, leaving a slight violet-coloured or brown spot without any cicatrix.

The silvery spot has been described by Dr. Robert W. Taylor of New York as a very unusual initial manifestation of syphilis. He says that it generally occurs on the glans and on the lips of the meatus, and at first it looks as if a spot of mucous membrane no larger than a pin's head had been touched with carbolic acid or with nitrate of silver. This peculiar staining of the superficial epithelial cells is alone evident even when the tissue is closely examined with a magnifying glass. The silvery lesion increases slowly but visibly day by day, and preserves its integrity of surface, whilst its base becomes more and more indurated until it reaches a maximum, when it gradually disappears, giving place to a smooth shiny surface like that of the chancrous erosion.

Any form of hard chancre may become gangrenous, may slough, or may be attacked by phagedæna in unhealthy or uncleanly persons.

The appearance of a hard sore is always followed in a week or ten days by an enlargement of the neighbouring lymphatic glands, and this infection of the lymphatic system is often a valuable help in diagnosis, for it shows that the disease is no longer local. In genital chancres the inguinal glands on the affected side are first affected, but the inflammatory condition soon spreads to the opposite side; in extra-genital chancres the lymphatic gland physiologically nearest the seat of inoculation is the first to become enlarged. The enlargement of the glands has to be inquired for and felt, because there are no symptoms of inflammation, and the patient is often ignorant of its occurrence. In simple cases the enlarged glands remain freely movable both upon themselves and beneath the skin, and one gland of a group is often larger than the rest, but if the chancre is suppurating they are readily converted into abscesses.

Many observers have studied the microscopic appearances of a hard sore, and have shown that the characteristic induration is due to a proliferation of small round cells which occupy the interstices of the true skin beneath and around the seat of inoculation, whilst in some places the deeper layers of the epithelium itself are invaded. Some of the cells, as might be expected, when they are so numerous and compact, undergo degenerative changes similar to those seen in the gummata developed at a later stage of the disease (p. 23). The blood-vessels, both arteries and veins, surrounding the chancre, as well as those at some distance away, are affected uniformly and at a very early stage of the inflammation, for the endothelial cells are swollen and proliferating, whilst the walls are infiltrated with the small round cells always found in syphilitic inflammations. The perivascular lymphatics soon become crowded with similar round cells, whilst the lymphatic vessels themselves are enlarged and thickened.

It appears, therefore, that the initial inflammatory lesion of syphilis spreads along the lymphatic spaces in the outer coats of the blood-vessels—the perivascular lymphatics—until the nearest lymphatic glands are reached, and from these glands the inflammation spreads to other glands more remote from the seat of inoculation. The general glandular enlargement, however, is evidence of constitutional infection, and is not the result of inflammation spreading from one chain of lymphatics to another.

Treatment of Primary Syphilis.—It is probable that in the case of syphilis, as in all other inoculable diseases, the virus takes some short time to enter the tissues, and that if any abrasion or sore could be disinfected shortly after inoculation, the further spread of the disease would be arrested. The circumstances under which syphilis is contracted, whether genitally or extra-genitally, are prohibitive of such disinfection, unless perhaps in the case of a surgeon or midwife knowingly inoculated in the course of their duties. Excision, cauterisation, and even the most careful disinfection are useless when the primary sore has become manifest, for analogy with all other infective diseases shows that the initial manifestation is only evidence of general infection. Yet the fears of patients have led to divers experiments in the way of local removal, but without any definite satisfactory results.

The treatment of primary syphilis, therefore, resolves itself into treatment of the chancre, and constitutional treatment of the disease of which the chancre is the local indication. The simplest means are usually sufficient to cure the chancre, which has indeed a tendency to undergo spontaneous resolution if it be not irritated and if it is kept clean. The sore in its simpler forms should be gently washed night and morning with warm boric lotion, a piece of dry gauze or lint being laid over it in the intervals to protect it from injury and to absorb any slight serous discharge which may be produced. More active measures must be taken when suppuration occurs, the bathing should be more frequent, and a lotion of 1 in 2000 biniodide of mercury may be substituted for the boric lotion. Many patients have a distinct objection to the use of iodoform, chiefly on account of its smell when it is carelessly applied, but it is often a most excellent application, and if care be taken not to spill it over the clothes it can be used with a minimum of discomfort. Black wash and lotio plumbi are also very serviceable applications whose advantages have withstood the test of time.

There is great diversity of opinion as to the proper treatment to be adopted constitutionally about the time of the appearance of a sore. Every one is agreed that mercury should be given as soon as syphilis is recognised, for mercury is the antidote to syphilis, and the induration of a hard sore disappears more rapidly when mercury is administered than when it is withheld. Every one, however, is equally agreed that the first and most important question to decide is that which is the most difficult in the majority of cases, viz.: "Is this patient suffering from syphilis, or is the sore which he presents due to some local inflammation?" The greater his experience the more does a practitioner recognise the many pitfalls which beset the diagnosis of syphilis in its earliest stages, and the more reluctant is he to pronounce a definite opinion in the many doubtful cases which come under his observation. It has become a rule, therefore, to adopt a temporising policy, and not to give the patient mercury until there is unequivocal evidence that he has really contracted syphilis. This appears to be a satisfactory plan to pursue until the diagnosis of syphilis is founded on some scientific basis, for at present it rests merely on clinical evidence. Mercurial treatment to be of any service requires a very prolonged course and a clear understanding of the principles involved both on the part of the surgeon and the patient. It is a waste of time and money to carry it out on a patient who has not syphilis, whilst if he has syphilis, and he knows it, he is the more likely to carry out the treatment in its integrity than if he has the lingering hope that after all he had only an inflamed soft sore. The constitutional treatment of primary syphilis consists, therefore, in the administration of mercury as soon as the evidence of syphilitic infection is irrefragable. Until this is established the patient should be given some tonic which may bring him into the best possible condition of health, with a view to the long and depressing period of treatment which is before him.

Secondary Syphilis.—The appearance of the primary sore is followed after a varying period by further and more generalised symptoms, which show that the syphilitic poison has increased within the body, and is now affecting the entire system. The secondary symptoms, as they are called, follow the initial manifestation in nearly every case. Sometimes they are so slight as to be entirely overlooked, both by the surgeon and by the patient, but in a few cases where the patient has been kept under the observation of reliable and experienced practitioners the secondary symptoms have not occurred. Indeed, there is some tendency to divide the various stages of syphilis, by lines which are too hard and fast, in accordance with Ricord's classification, into primary, secondary, and tertiary syphilis. Nature rarely works by abrupt divisions, and in syphilis, as in all other diseases, the symptoms of one stage merge into and often coexist with those of another. It may be stated, with these reservations, that the secondary symptoms of syphilis occur about six weeks after the appearance of the initial manifestation, and that the secondary stage lasts from one to two years.

The patient often presents no symptoms of constitutional infection for some time after the appearance of the initial lesion, though a careful examination will show that the lymphatic glands are becoming enlarged in various parts of the body. The glands do not attain any great size, they show no tendency to suppurate, and they are freely movable in the surrounding tissues and upon each other. They do not usually cause any pain or discomfort, so that they may pass entirely unnoticed by the patient, even when their outline is clearly visible to the eye of a trained observer. The chain of glands at the posterior border of the sternomastoid muscles—the *glandulæ concatenatæ*—the posterior occipital glands, and those behind the ears, are most commonly enlarged and are most easily felt. The epitrochlear glands, situated two or three fingers' breadth above the internal condyle of the humerus, are said to be so uniformly enlarged in syphilis as to be almost pathognomonic if the more ordinary causes can be excluded. The epitrochlear gland is examined by bending the patient's elbow, slightly adducting his arm, and placing the hand outside his arm so that the fingers are inserted into the groove between the biceps and the triceps. The enlargement is not limited to the superficial glands, for the prevertebral, the lumbar, iliac, and femoral glands are often affected, the mesenteric glands being more rarely involved. This glandular enlargement is wholly independent of any skin or visceral lesion. It remains for an indefinite period, though the glands generally diminish in size when mercury is administered, and the number and position of the glands involved varies in every individual.

The patient often presents certain symptoms of malaise in the interval between the appearance of the sore and the secondary symptoms, which can only be considered as evidence of a progressive absorption of the syphilitic poison by the various tissues of the body. These symptoms are often so slight as to constitute little more than a malaise, which might be attributed to the popular dread of the disease if similar symptoms did not occur during the prodromal period of tetanus and hydrophobia, where we know that toxins are being produced in an infected body. The patient complains of a sense of general discomfort, with weakness, lassitude, and disinclination to follow his usual occupations; he may be sleepless, and his appetite fails; his complexion becomes sallow, his skin is pale and dry, and his eyes are dull and heavy-looking. He has "rheumatic" pains in his bones and joints, which are worse at night, and he suffers from neuralgia of the face and scalp, or even of the intercostal and sciatic nerves. The painful joints are sometimes a little swollen by a serous synovitis. These vague symptoms may culminate in a sharp attack of fever, which precedes by a few days the first decided sign of secondary syphilis.

The fever which ushers in the secondary manifestations of syphilis is often considerable, for the temperature may rise to 104° F., being high at night and falling nearly to normal in the morning. It rarely lasts more than three or four days, and it is occasionally distinctly remittent in character. There is a corresponding quickening of the pulse, and the respiratory rhythm is accelerated. A faint blush may appear at different parts of the trunk whilst the patient is still feverish, but the blush disappears and the temperature falls in many cases as soon as the first rash becomes visible.

A remarkable peculiarity of the syphilitic poison is the readiness with which it attacks points of least resistance in each body in much the same manner as does influenza. The full force of the syphilitic inflammation is felt by different tissues in different individuals: thus in one the mucous membranes suffer most; in another the fibrous tissues, so that the bones, joints, and blood-vessels are unduly affected; whilst in another the nervous system, and in yet another the viscera, are more particularly attacked. It is not surprising, therefore, to find that a typhoidal condition, a temporary inflammation of the kidneys, pleurisy, enlargement of the spleen, and many other indications of localised but transient syphilitic inflammation occur during the early periods of secondary syphilis.

AFFECTIONS OF THE SKIN (*Cutaneous Syphilide*).—The affections of the skin are certainly the most important signs of secondary syphilis, for until they appear it is at present impossible to say that a patient has acquired syphilis. The mucous membranes are implicated simultaneously with the skin, the lesions being called condylomata or mucous patches.

The cutaneous syphilides are either scaly, papular, eczematous, pustular, or bullous, for, as Mr. Jno. Hutchinson has well said, "while syphilis may imitate all forms of skin disease, it can create no originals." The rashes of secondary syphilis, as a rule, only involve the superficial layers, so that they do not often ulcerate, and they have certain features which seem to distinguish them from similar eruptions which are not of syphilitic origin.

The secondary syphilitic rashes, like all other manifestations of secondary syphilis, are comparatively slight, and, unless they are subject to irritation or pyogenic infection, have a tendency towards spontaneous cure. They differ in this respect from the tertiary manifestations of syphilis, which ulcerate and show no disposition to undergo resolution.

Cutaneous syphilides are remarkable for the slowness with which they develop and run their course. A few spots may appear many days before the general eruption becomes visible, and as the rash is unattended by inflammation or itching, a careless or unobservant patient may be ignorant of its presence.

Cutaneous syphilides do not present more than a superficial resemblance to the forms of skin eruption which they mimic. They develop in successive crops, and a close examination of the individual spots forming the rash shows that they are not all alike, so that in one place they are maculæ, at another papules, whilst scaly patches may be mingled with pustules. The absence of active inflammation renders the colour of the rash less bright in syphilis than in the ordinary form of skin disease, and the rash is often said, therefore, to be of the colour of lean ham; for the same reason the eruption stands out markedly in syphilis, as there is no surrounding inflammatory zone, whilst the scales in the desquamating forms are less numerous and more easily detached than in simple dermatitis. There is often a tendency for the spots to develop in curved lines owing to the anatomical arrangement of the capillaries in the skin, and these crescentic, serpiginous, and horseshoe shapes are especially well marked in the ulcerating eruptions of the tertiary stage of syphilis.

Syphilitic eruptions are also found in positions which are not usually affected by the non-syphilitic forms of skin disease. Many forms of secondary eruption are found on the scalp where the hair ends on the forehead, and papules are not uncommon on the face, back of the neck, trunk, and limbs. The erythematous syphilide appears on the chest, trunk, and flexor aspect of the limbs, whilst the squamous form is usually seen on the plantar and palmar surfaces of the feet and hands where the sebaceous follicles are absent. Pustular syphilides resembling acne and impetigo naturally occur where the sebaceous glands are most numerous, and are therefore common in the scalp and the more hairy portions of the body. Ecthymatous and rupial manifestations affect the lower limbs and the trunk most frequently, whilst tubercular nodules occur in any part. Mucous patches and condylomata are formed wherever the skin is thin, moist, and subject to irritation. They are found, therefore, at the margins of the lips, the edges of the nostrils, within the mouth, at the genital and anal folds, near the umbilicus, and between the toes. Certain regions of the body, on the other hand, are nearly exempt from syphilitic dermatitis, though they are not uncommonly affected by parasitic and simple eruptions. Thus the back of the hand, where scabies is common, and the supraclavicular and infraclavicular regions, where it is not unusual to find evidence of lice, are remarkably free from the earlier manifestations of secondary syphilitic skin eruptions.

Treatment.—The treatment in all cases of cutaneous syphilis consists in the internal administration of mercury in the form best suited to the individual patient (p. 16). White precipitate ointment is generally serviceable as a local application, and great benefit will often be derived from mercurial fumigations.

SYPHILITIC AFFECTIONS OF THE HAIR AND NAILS (*Alopecia*).—The structural connection of the hair and nails with the skin renders these appendages especially liable to alterations as a result of syphilis. The hair is affected equally in men and women. It falls out either wholly or in patches soon after the first general eruption on the skin, and this is most often about the second month, though the alopecia may be delayed until the second year after infection.

The prognosis in every case is good, and after a longer or shorter time the hair grows again, even when the alopecia has been complete.

The treatment consists in cutting the hair short, washing the bald surface with soap and water every night, and afterwards rubbing in an ointment made by incorporating half a drachm of white precipitate ointment with an ounce of cold cream or other convenient ointment.

Onychia and Paronychia.—Secondary syphilis may affect the nails either by setting up trophic changes in the matrix—onychia—or by causing a chronic inflammatory condition of the connective tissue of the ungual phalanx in the neighbourhood of the nail—paronychia—which leads secondarily to implication of the matrix. These changes usually occur within the first year after infection with syphilis. As a result of onychia the nail is rendered brittle, grows craggy, is partially detached, or may be shed entirely. The fingers and toes are equally affected. Paronychia may end in ulceration and destruction of the nail, or it may remain as a chronic thickening of the whole border where the nail is inserted into the skin of the phalanx.

The treatment in the ulcerating forms lies in the application of compresses soaked in a solution of perchloride of mercury (1 : 1000), any exuberant granulations being restrained by the application of nitrate of silver or nitric acid. The use of a finger-stall to protect the nail will be useful in the simpler cases when the fingers are affected. As the lesions are rarely isolated manifestations of syphilis, the patient is usually taking mercury when they appear.

THE MUCOUS MEMBRANES.—The manifestations of syphilis on the mucous membranes are of great practical importance, because they are very common and are highly infectious. The mucous membrane of the mouth is affected by a diffuse erythema and by mucous patches. The erythema is especially liable to affect the uvula, the tonsils, and the larynx, causing the sore throat which is well known as a sign of secondary syphilis. The inflammation appears about the same time as, or a little before, the first syphilitic rash. The sore throat is very chronic, and is peculiarly liable to recur from time to time during the first year after infection. The earliest symptom is dryness of the fauces, with slight pain on swallowing, but as the inflammation progresses there is a copious flow of mucus. Examination of the throat at an early period shows that the velum palati, the pillars of the fauces, and the tonsils are uniformly red. In a few days the redness becomes abruptly limited and symmetrical. It never fades away gradually into the surrounding healthy tissues, but is bounded by a distinct line of demarcation. In the further course of the disease the mucous membrane shows sharply defined erosions covered with a red or whitish deposit, and surrounded by a narrow zone of infiltration. Gradually the erosion heals, the infiltration disappears, and for a time the inflamed mucous membrane appears reddish-brown from congestion.

Mucous Patches are most frequently found upon the tonsils, the uvula, the velum palati, and pillars of the fauces, the sides of the tongue, and the mucous surface of the lips, especially the lower. They are often found, too, at the angles of the lips, on the inner surface of the cheek near the last molar tooth, or opposite any point of irritation, and their presence should not be overlooked when they occur on the gums. At first the mucous patches are very slightly elevated, circular or elliptical in shape, and they are often multiple. At a later stage they become the seat of shallow ulcerations with a greyish-yellow surface and uneven edges. This colour makes the patches appear as if they had been formed by pencilling the surface with nitrate of silver, and it is in allusion to this characteristic that they are often called "Plaques opalines" by the French writers on syphilis.

Prognosis.—Mucous patches disappear without leaving any trace in about a month, under simple treatment, in people who are careful to keep their mouths clean and free from irritation, but the patches recur again and again, as a rule, during the first period of secondary syphilis, and as they are a constant source of infection the practitioner should keep them well in mind when he sees his patient. In unhealthy people, and in those who are careless and dirty as regards their mouths, mucous patches may cause considerable trouble, because they may ulcerate rather deeply, or they may coalesce to form larger masses. They often become cracked, especially at the corners of the mouth, where they may lead to permanent scarring, as is often seen in children who have been the subjects of syphilis.

Treatment. — The patient should be warned of the risk he runs of conveying the infection to other persons by kissing, using drinking-vessels or eating-utensils in common. He should be exhorted to use gargles of borax, chlorate of potash, or alum at frequent intervals. I usually paint the patches with chromic acid solution of the strength of 10 grains to the ounce, alternating it occasionally with potassium bicyanide, 15 grains to the ounce. Local applications of chloride of zinc, 20 grains to the ounce, or of nitrate of silver, 30 grains to the ounce, are also useful, and the application of tincture of iodine is sometimes very serviceable. But it is well in every case for the practitioner to make the application himself, either with the patient in a good light or with his throat illuminated from the head mirror of a laryngoscope, as he will then be able to make a methodical investigation of the whole of the mucous membrane of the mouth and pharynx. All causes of irritation should be removed as far as possible, so that smoking should be prohibited, and stimulants forbidden.

The mucous membrane of the tongue, like that of the mouth generally, may be the seat of an erythema or of mucous patches, but as it is somewhat more liable to irritation, and has a thicker covering of epithelium, it proves more refractory to treatment. Various fissures are developed, and the epithelium undergoes modification into the condition known as psoriasis of the tongue, or leukoplakia.

Secondary symptoms of syphilis are rather rare in the *nasal mucous membranes.* They are usually nothing more than a slight hyperæmia of the mucous membrane, leading to a chronic catarrh with a muco-purulent secretion. Mucous patches can sometimes be seen at the external angle of the nostrils, or just inside the nasal fossæ either on the anterior part of the septum or on the inferior turbinate bone. Similar patches may be seen by posterior rhinoscopy on the margins of the posterior nares.

The treatment consists in the administration of a nasal douche of Condy's fluid, two drachms to a pint, or of bicarbonate of soda, 30 grains to the ounce. The larynx is affected with tolerable frequency during secondary syphilis, either in the form of a chronic hyperæmia, superficial ulceration, or as condylomata. The condylomata generally appear as smooth yellow projections, either round or oval, and varying in diameter from an eighth to a third of an inch. They are usually situated on the epiglottis and on the inter-arytenoid commissure, more rarely on the vocal ends themselves, and being less exposed to irritation they are not so liable to ulceration as the condylomata occurring on the pharynx. The laryngeal manifestations of secondary syphilis generally occur from six to twelve months after infection.

The symptoms are generally slight, a little cough and hoarseness, which may pass on into complete aphonia, being all that the patient complains of. A perchloride of mercury spray of the strength of 1 in 1000 is often of great service when it is combined with the internal administration of mercury.

The neighbourhood of the anus, the vulva, and the inguinal folds are often the seat of flattened ulcerated patches, secreting a scanty viscid secretion, which are known as condylomata lata. The discharge is often stinking, and is highly infectious. Condylomata are associated with a great want of cleanliness on the part of the patient. They are cured by keeping the parts perfectly clean and dry, whilst the patient is put upon a course of mercury. The drying is ensured by dusting the condylomata with a mixture of calomel and oxide of zinc, or if the discharge is too profuse the patient may be placed in a bath of perchloride of mercury of the strength of one-half to one per cent. Condylomata of long standing, or which are exuberant, may require the application of a Pacquelin's cautery or of cauterisation with nitrate of silver.

The Eye.—Iritis.—Inflammation of the iris is one of the chief manifestations of secondary syphilis in the eye, as it has been estimated that nearly 60 per cent of all cases of iritis are due to this cause. It may occur within six weeks or two months of the primary lesion, and is often accompanied by cyclitis. It is usually acute, one eye being first affected, though the other eye soon becomes inflamed.

Symptoms.—There is some congestion of the conjunctiva and circumcorneal zone, with photophobia and lacrymation. The pain, however, may not be a very marked feature, though the patient may complain of some neuralgia over the forehead and down the side of the nose. In a typical case one or more beads of lymph can easily be seen to be situated upon the iris, and the pupil is small and irregular in shape. More often, however, no such beads of lymph are present, and the whole iris appears thick and dull. The inflammation runs its course in about a month or six weeks, and is singularly amenable to treatment by mercury. Relapses are not very common in cases which have been cured by treatment, but if they are left to undergo resolution it is not unusual for adhesions to be formed between the margin of the iris and the front surface of the lens. These synechiæ may be the cause of fresh irritation, which results in renewed attacks of iritis, or, if complete, they may cause a chronic inflammation ending in glaucoma.

Treatment.—The after-effects of a neglected syphilitic iritis are so disastrous that every effort must be made to cure it absolutely. The patient should be kept in a darkened and well-ventilated room so long as he complains of photophobia, and he should be forbidden absolutely to use his eyes. Repeated instillations of sulphate of atropine, 2 grains to the ounce, with fomentations of belladonna, are imperatively called for until the pupil is widely dilated and the inflammation has subsided. These instillations may be supplemented with fomentations of belladonna, as by these means the tendency to the formation of synechiæ is reduced to a minimum. If atropin increase the tendency to conjunctivitis, it must be replaced by duboisin or hyoscyamin. Three leeches or a small blister applied to the temple, where the hair has been shaved away over a small area to hide the subsequent scars, will often relieve the pain. The patient must be put upon full doses of mercury (p. 17), which should be increased rapidly until there are symptoms of slight salivation, when the amount must be cautiously reduced. Much care must be exercised when recovery has taken place, especially if synechiæ are present, and the patient should report himself to his ophthalmic surgeon from time to time, to enable an ophthalmoscopic examination to be made.

Ear.—As the external ear is only a part of the skin, it is occasionally affected with an erythema, which may involve the mastoid region, the auricle, or even the membrana tympani. A condyloma is sometimes formed within the external auditory meatus, where it may give rise to much discomfort and considerable discharge. The treatment is identical with that recommended for secondary syphilitic affections elsewhere, viz. a course of mercury internally, cleanliness, and drying of the local manifestation.

Treatment of Secondary Syphilis

The methodical treatment of syphilis begins as soon as the disease can be diagnosed with certainty, and in the majority of cases this is not until the appearance of the secondary symptoms. A good prognosis may be given in young patients who are otherwise healthy, for they may be told that if they will submit themselves to a thorough course of treatment the secondary symptoms can be kept well under control, and it is improbable that they will suffer from any tertiary signs unless perchance they are subject later in life to some unusually debilitating influences. On the other hand, the intemperate, the tuberculous, the rheumatic, the gouty, the malarious, and those who are suffering from any wasting or debilitating disease do not bear syphilis well, and it is advisable to warn such patients at the outset that their cure will be harder and will take a proportionately longer time.

The broad facts to be remembered in connection with syphilis are as follows, so far as they can be based upon our present knowledge of the pathology of the disease. Syphilis leads to a chronic inflammation of the connective tissues, as is shown by a multiplication of small round cells. In the early stages these small round cells have a tendency to degenerate in various ways, this tendency being controlled by the administration of mercury. In the later stages the tendency to degenerate is associated with certain conservative changes, for there is a production of imperfect fibrous tissue. This formation of fibroid tissue is controlled by the use of iodides. The stress of the disease in syphilis usually falls upon one system, *e.g.* the bones, the skin, the nervous system, the visceral organs, and in some cases a definite cause may be discovered to account for the predilection. But any independent condition or disease which unfavourably modifies the connective tissues of an organ, or even of the whole body, will unfavourably influence the course of syphilis.

It does not matter materially by what means mercury obtains access to the tissues, so long as it is presented to them in a form which they can assimilate. It may pass by absorption through the mucous membrane of the alimentary canal: it may be taken up by the cells of the sebaceous and sweat glands of the skin, or it may be introduced directly into the lymphatics of the connective tissue.

Internal Administration.—It should be remembered when mercury is given by the mouth, that it is liable to act as an irritant during its passage over a long tract of delicately adjusted mucous membrane, whose tendency is towards inflammation if the balance be disturbed, and whose secretions, now acid, now alkaline, aided as they are by the unknown action of the intestinal micro-organisms, may alter the chemical constitution of the mercurial preparation so as to make it a violent irritant.

Mercury in long-continued doses is a depressing remedy, and is especially badly borne by those who are predisposed to tubercle. In syphilis, mercury must be given for many months, and in sufficient doses. Other considerations, therefore, have to enter into the course of treatment besides that of the particular form in which the drug is to be administered. The hygiene of the patient both locally and generally must be carefully attended to, and he must be maintained in the pink of condition, so far as his circumstances will allow. The surgeon must become thoroughly acquainted with the physical, mental, and moral peculiarities of his patient, for in the case of a prolonged course of treatment he will often have need to deal with every aspect of his character.

The local hygiene will consist in a careful regulation of the teeth by a competent dentist. Tartar should be removed, caries should be arrested, and every cause of local irritation should be averted. The patient should be told plainly that the irritation of smoking tends to promote the formation of mucous patches in the mouth, and that by their presence he may infect others. The function of the alimentary tract should be brought to the highest level of perfection by correcting dyspepsia and relieving constipation, whilst the most strict moderation is enjoined both in eating and drinking.

The general hygiene consists in warning the patient against any excess, whether of fatigue or luxury. Regular habits, early hours, and moderate exercise will amply repay the patient by shortening the term of his cure, and these simple means have built up the reputation of many a spa as a syphilis-curing watering-place. Indeed, the only way to secure these advantages to a patient is often to send him to such a place, for so long as he stays at home he will take no care of himself.

I think it is best to begin the administration of mercury in syphilis by the method of internal administration, and of all the preparations of mercury it is certain that for English use grey powder or hyd. cum cret. is the best. It is easily carried about in a compressed form, each tabloid containing three grains. The patient should be ordered to take a tabloid three times a day directly after a meal. Perchloride of mercury comes next in favour, and it has the advantage that it can be readily prescribed with iodide of potassium when it is considered advisable to give the two drugs together. The dose is a drachm of the solution of perchloride of mercury, containing a sixteenth of a grain of hyd. perchlor., in an ounce of chloroform water. The protiodide of mercury, hyd. iod. viride, or hydr. iod. flavum, is also very largely used in the treatment of secondary syphilis. The dose is a quarter or a third of a grain given three times a day directly after food, the quantity of the drug being increased during the first fortnight to a grain and a half or two grains thrice a day. It may often be usefully combined with 2 to 4 grains of the green extract of hyoscyamus. Tannate of mercury in half-grain doses with sugar of milk has attained considerable repute, but its action must be watched rather more carefully than the other preparations, as it may cause much gastro-intestinal disturbance. Many other preparations of mercury have been brought forward from time to time, calomel and blue pill being the older forms; carbolate, salicylate, and alanilate the more recent; but they do not seem to be so satisfactory in their actions as those recommended above. Zittman's method of giving mercury is described at page 22. It must be borne in mind, however, that no single preparation of mercury can be administered in a routine manner, because a preparation which suits one patient cannot be taken equally well by another, nor by the same patient at all times. The surgeon, therefore, has to vary both the preparation and the means of administering the drug. Symptoms of salivation, pains in the chest, and gastro-intestinal disturbance are the most common symptoms which prove troublesome during a course of mercury, and it is well to try and combat these symptoms by a temporary reduction in the dose, a modification in the food, and a limitation of the quantity of fluid ingested, rather than to fly at once to the administration of opium or Dover's powder. A little essence of ginger, peppermint, or other carminative will often be sufficient to give relief. The administration of mercury must be carried on for at least six months from the time the diagnosis of syphilis has been first made. I prefer to give the patient a rest from mercury by the mouth for three days at the end of each month, and a fortnight at the end of the third month, and it is often necessary to suspend or reduce the dose for a day or so on account of trifling digestive disorders; but so long as the weight of the patient is maintained, and he appears to be improving, the dose of mercury should be steadily administered. For this purpose I cause the patient to be weighed every Saturday, if possible upon the same machine, the record of his weight being put into writing at once.

Inunction.—The method of administering mercury by inunction comes next in efficacy, even if it do not surpass the plan of internal administration during the secondary stage of syphilis. Inunction, however, has its limitations, and they are even more marked than those of the method usually adopted. It is dirty, it requires time, it is likely to give rise to a troublesome eczema, and it produces salivation unless it be administered carefully. Inunction is often serviceable for a short time whilst the patient is resting from the internal administration, so that it may be employed for a fortnight once in three months.

The following directions are to be given to the patient. He is to procure freshly prepared blue ointment put up in gelatin capsules each containing thirty grains. He retires early in the evening, and takes a warm bath, thoroughly washing the parts to be anointed with soap and water. He then dries himself and puts on pyjamas and a flannel dressing-gown, his room of course being warmed in cold or damp weather. The most accessible hairless regions are employed for the inunction. These are the inner surface of the thighs, the inner surfaces of the arms and forearms, the sides of the chest, the loins, the buttocks, the soles and the inner surface of the feet. One of these regions is selected in order, so that each part only receives its inunction occasionally. The part to be anointed is sponged over with a solution of biniodide of mercury of the strength of $\frac{1}{1000}$, and afterwards gently dried with some absorbent wool, for it is important that the skin should be kept aseptic. Twenty grains of the blue ointment are then smeared over the surface of the skin at the selected spot, and briskly rubbed in with the hand over as large a surface as possible, and for not less than twenty minutes by the clock, an additional ten grains being added during the inunction. All the ointment should have disappeared by the time the inunction is complete and the skin presents a greyish colour, as if it had been lightly blackleaded. The patient then takes off his dressing-gown and goes to bed, after washing his hands with soap and hot water to remove any ointment which may be adhering to them. He has a warm bath on the morning following the inunction to remove any ointment which has not been absorbed or rubbed off during the night. The dose of ointment may be gradually increased from half a drachm to sixty or ninety grains, though in some cases it may be necessary to give more.

The results of this method of treatment are often very satisfactory. The patient begins to gain in weight, his appetite returns, his digestion improves, he sleeps well at night, and he ceases to be listless. In such cases, and when mercury is badly borne during internal administration, the method of inunction may be continued for 50 to 100 days, the patient being carefully watched during the second and third weeks, when he may suddenly develop a troublesome stomatitis. If special care be taken to keep the skin aseptic and to avoid rubbing the ointment into hairy parts, the risk of dermatitis will be materially reduced. It is well to secure the services of a professional rubber in these prolonged courses, though of course with an intelligent patient it is not absolutely necessary.

Fumigation.—Some cases of dense or widely distributed eruptions on the skin and of obstinate ulceration receive much benefit from fumigation with mercury when other methods have failed. This plan of giving mercury fell into disuse owing to the difficulty of administration, but of late years, with the invention of cheap and portable Turkish baths, it has been somewhat revived. The patient sits naked in the vapour bath, and below him thirty grains of calomel are vaporised by a small spirit lamp. The vaporisation takes twenty minutes, and at the end of that time the lamp is extinguished and the patient remains in the bath ten minutes longer to cool. He then goes to bed. It is only necessary to volatilise the calomel and not to add any water, for profuse perspiration on the part of the patient will defeat the object for which the bath is given. In all cases the patient should be within easy reach of help whilst he is taking the bath, as he may faint or be accidentally scorched. The baths should not be taken directly after meals, and at first they should only be administered every other day. They may be continued for a month or two if the result is satisfactory, but they are more often used temporarily and for a special purpose.

Hypodermic Injection.—The desire of many men to advance their art, and the wish of patients to be cured of syphilis by some short method which shall cut at the root of the disease, have lately led to the treatment of syphilis by the hypodermic injection of a very large variety of mercurial preparations, some soluble, others insoluble. The method has fallen into disrepute from the unwarrantable claims made in its behalf. There is no rapid cure of syphilis, and practitioners mislead their patients if they hold out to them any hope of materially shortening the ordinary course of treatment by any method known at present.

There are, however, some conditions under which hypodermic injections of a mercurial preparation may be usefully employed. When mercury is badly borne by the alimentary tract, or by the skin, a hypodermic injection is sometimes well borne, and as it is imperative that mercury should be given in syphilis, such injections are then advantageous. In like manner hypodermic injections are to be given when an acute inflammation of the bowels, lungs, liver, or throat make it unwise to give mercury by the mouth. Then there are the unhappy class of patients who are always wanting some alteration of treatment, or who, demanding that something more may be done, receive some moral support by the slight physical pain attending this administration.

The chief soluble salts of mercury which have been recommended for hypodermic administration are corrosive sublimate from a twelfth to three-quarters of a grain: asparagin-mercury made by dissolving two and a half drachms of asparagin in warm water and adding oxide of mercury to saturation. The solution is filtered, and the mercury being estimated, fifteen minims of a 1 per cent solution are injected. The succinimide of mercury, the oxycyanide, the iodo-tannate, the carbolate, the formamide, the alaninate, and the benzoate, have all been employed with varying success. The insoluble forms are mercury itself, calomel in doses of one-half to two grains, the yellow oxide, the neutral salicylate, the thymolacetate, and many other forms. Grey oil, oleum cinereum, was introduced by Dr. E. Lang, the Professor of Dermatology and Syphilography at Vienna. It is made by making an ointment of mercury with lanoline as a basis and then diluting with oil of vaseline. (The actual formulæ are, Lanolini anhydrici ʒiv., chloroform ℥iss. Evaporate in a large mortar with continual stirring, then add Hydrarg. vivi depur. ℥j. Stir slowly until the chloroform is wholly evaporated and the metallic mercury can be no longer distinguished. Add 135 grains of this ointment to 45 grains of vaseline oil, the oil being added so gradually and with such constant stirring that a smooth, oily mixture is obtained. Keep in a wide-mouthed phial with a glass stopper. The dose of this preparation is one minim for an injection.

Perchloride of mercury seems, however, to give the best results in the hypodermic injection of mercury. The solution must be freshly made, and should be so standardised that ten minims contain a quarter of a grain of corrosive sublimate. Five minims of this solution are injected on the first occasion, and the dose is gradually increased to a quarter, five-eighths, or even three-quarters of a grain. The injection should be given every second or third day, though the intervals must be longer if symptoms of commencing salivation appear. The injection is made into the subcutaneous tissue, care being taken to avoid the puncture of a vein. A point is selected which is not liable to accidental irritation or contamination, and for this reason the depression behind the great trochanters of the femur is often chosen. Many surgeons, however, prefer to throw the injection deeply into the substance of the gluteal muscles. It is absolutely necessary that the skin of the patient, the solution, the hypodermic syringe, and the needle should be absolutely sterile, and the greatest care must be taken to secure this asepsis. A piece of cyanide gauze soaked in collodion should be applied over the seat of puncture. Yet in spite of every precaution abscesses may be formed at the punctures, because a patient debilitated by syphilis is prone to suppurate on the very smallest provocation.

An attempt has been made to administer mercury by means of baths, the best known form of bath being one of corrosive sublimate with or without the use of electricity. Gaertner's bath consists of two cells, which should be divided by a properly fitted diaphragm. Each cell is attached to one pole of a battery consisting of about fifty large Leclanché elements; the box which contains the battery is supplied with a finely graduated rheostat, a galvanometer, and a commutator. About half an ounce of corrosive sublimate is thoroughly dissolved in a warm bath, and as soon as the patient is immersed the diaphragm is put in place, the poles of the battery are attached, and the current is gradually increased by means of the rheostat until it is of the strength of 200 milliampères. The current is allowed to flow through the bath for a quarter of an hour, it is then reduced, reversed, and again increased from 100 to 200 milliampères. At the end of a second quarter of an hour the current is shut off and the bath is finished. These baths are said to be especially serviceable in the treatment of mucous patches and other forms of cutaneous syphilis.

Salivation.—People vary greatly in their susceptibility to mercury, some can take the drug in considerable quantities for long periods of time, whilst others are readily affected by small doses only given for a short period. In the slighter cases of salivation which warn the surgeon that his patient has reached the limit of tolerance, there is a slight inspissation of the saliva, which becomes tough, stringy, and increased in quantity. The teeth are tender when the jaws are snapped together. The patient begins to look pale, he loses his appetite, and may complain of headache, giddiness, and transitory pains in his limbs. The muscles of the face twitch, the fingers tremble when they are spread out, and the tongue is tremulous when protruded. The patient often becomes shy and nervous when he thinks that he is being watched, he sleeps badly and often has nightmare. A rash may also appear on the skin, either as an erythema, a wheal, or an ecchymosis. The rash runs its course in a few days, ending in degeneration. In the more marked cases of salivation the patient complains of a coppery taste in his mouth, his breath smells offensively, there is some ulceration of the gums with congestion and œdema of the mucous membrane of the mouth, which may extend backwards until the tonsils and pharynx are involved. The teeth may become loose, and there is an enormously increased flow of saliva, with swelling of the parotid and submaxillary glands. The psychical condition changes from shyness to despondency, and in women menstruation is diminished or ceases.

It often happens that a course of mercury produces symptoms connected with the intestinal canal rather than with the mouth. The patient complains of colicky pains with abdominal rumbling and diarrhœa shortly after taking each dose of the medicine, and the diarrhœa may be so severe as to be bloody.

Treatment of Salivation.—Commencing salivation indicates that the amount of mercury taken by the patient must be diminished. The teeth should be brushed once or twice a day with equal parts of tincture of myrrh and tincture of iodine. Great care should be taken to prevent any accumulation of food between the teeth, and the patient should be directed to wash out his mouth with a saturated solution of boric acid after each meal. Alum and chlorate of potash, of each a drachm and a half in twelve ounces of water, also forms a good mouth wash; whilst if the breath be foul a drachm of the chlorinated soda may be mixed with an ounce of brandy in four ounces of water to serve as a gargle. Atropin is alone of service in checking the profuse salivation. It should be given frequently in small doses in the form of powders, which are allowed to dissolve in the mouth. A thirty-second of a grain of atropin mixed with a drachm of sugar of milk may be divided into ten powders, of which one may be given every four hours until the pupil begins to dilate. Five or ten grains of Dover's powder given at night are usually sufficient to allay the intestinal symptoms, which are often marked at the beginning of the mercurial course, but the use of opium should not be persisted in, and the symptoms disappear spontaneously in many cases after a few days' discomfort. A tonic treatment by the administration of quinine and iron may be given for a short time after the symptoms of salivation have disappeared, before the patient recommences his mercurial course. There is no doubt that, even after a prolonged course of mercury, the whole of the drug is eliminated from the body within two years of the last dose being taken, though there is a popular belief that when mercury once gets into "the system" it is never afterwards got rid of. It is chiefly excreted by the kidneys and skin. Patients with renal disease, therefore, are bad subjects for a prolonged course of mercury; and though albuminuria does not necessarily contraindicate the use of mercury in the treatment of syphilis, it makes the surgeon somewhat more careful in the watch he keeps upon his patient. People who suffer from tubercle, malaria, advanced anæmia, the hæmorrhagic diathesis, and chronic disease of the alimentary tract also bear mercury badly as a rule.

TERTIARY SYPHILIS

It must be remembered that the expression tertiary syphilis is only used for the sake of convenience to express the latest manifestations of syphilis, which are more refractory to treatment than the earlier signs. The symptoms of tertiary syphilis usually appear during the third or fourth year after infection, but they show themselves as early as the second or fourth month, or they may be delayed until some debilitating cause weakens the general health of the patient. In favourable cases and under proper treatment no tertiary symptoms may present themselves, the patient being cured in the secondary stage.

Malignant Syphilis.—In some unfortunate cases an attack of syphilis runs a malignant course which often terminates in death. The skin eruptions are a marked feature in malignant syphilis, and they quickly ulcerate, but the mucous membranes are only slightly affected. The bones and nervous system show evidence of the syphilitic poison, and the whole organism is seriously affected, as is shown by the fever and cachexia. Pathology will not as yet explain the cause of malignant syphilis, though it is probably the same as that of malignant scarlet fever, acute septicæmia, and malignant smallpox, *i.e.* a diminished power of resistance of the part of the tissues rather than an increased virulence of the infective agent. Such cases of malignant syphilis have been observed in individuals who have seemed otherwise to be in good health, as well as in those suffering from dysentery, tuberculosis, scurvy, anæmia, and chronic alcoholism.

Treatment.—Mercury is badly borne in these cases, and iodide of potassium is often found to be too depressing. Sir Alfred Cooper speaks very highly of Zittman's regimen, of which he gives the following account:—"The course of treatment extends over a fortnight, during which time the patient is put upon a strict diet and regimen. The following are the details of this method of treatment.

The decoctions and pills are made from the following formulæ:—

Zittman's decoction No. 1.

℞ Rad. sarzæ contus. ℥iv., sem. anisi contus., sem. fœniculi contus. āā gr. 80, fol. sennæ ℥j., rad. glycyrrhiz. contus. ʒiv.

And in a linen bag:—

Sacch. alb., alum. sulph. āā ʒij., hydrarg. subchlor. gr. 80, hydrarg. bisulph. rub. gr. 20, aquæ C. iij.

Boil down gently to one gallon, strain and put into four forty-ounce bottles. Label—The Strong Decoction.

Zittman's decoction No. 2.

To the dregs of No. 1 decoction add:—

Rad. sarzæ contus. ℥ij., cort. limon. contus., semin. cardamom. contus., rad. glycyrrhiz. contus. āā ʒj., aquæ C. iij.

Boil gently down to one gallon, strain and put into four forty-ounce bottles. Label—The Weak Decoction.

℞ Hyd. subchlor. gr. ij., ext. colocynth. co. gr. v., ext. hyoscyami gr. ij.

M. Ft. pil. ii. signa.—the Pills.

The patient is kept in a room at 80° F. The diet consists of:—

Breakfast—Boiled egg or bacon, tea, no sugar or spices. Lunch—Butcher's meat, vegetables, no fruits. Dinner—Soup, fish, poultry.

The evening before beginning the treatment, the two pills are taken, and for the next four days at 9 a.m., 10 a.m., 11 a.m., and 12 noon, half a pint of the strong decoction is to be drunk very hot, and at 3 p.m., 4 p.m., 5 p.m., and 6 p.m., half a pint of the weak decoction cold. The patient is kept in bed except for an hour in the evening. He is allowed to get up on the fifth day, he may then have a hot bath and dress, and is allowed, if he asks for it, a little brandy, or whisky and soda. In the evening two pills are administered, the patient starting the decoctions as before. So the treatment goes on until the fifteenth day, when it is discontinued.

Any one who has not witnessed the results obtained by this method of treatment, when the iodide and mercury plan have been pursued with no apparent benefit, will hardly credit us when we state that we have seen many cases in which ulceration was progressing rapidly in spite of ordinary antisyphilitic treatment, quite heal up under a course of Zittman." So, too, among the subjects of chronic syphilis affecting the nervous system, we have had many successful instances treated by this method and strongly recommend it in selected cases.

Course of Tertiary Syphilis.—Cases of malignant syphilis, however, are fortunately of rare occurrence, much more rare indeed than the cure of syphilis in the secondary stage. The usual course is for the patient to present slight but continuous symptoms of syphilitic poisoning in the form of eruptions on the skin, which gradually cease to show the symmetry characteristic of the secondary rashes. The mouth and throat are implicated in the changes, and the lesions no longer show a tendency to run a definite course and to disappear, but are rather inclined to become chronic, ulcerate, and even slough. The connective tissues are still most affected, and the stress of the disease generally falls upon one part of the system more than upon another, so that in one person the bones and periosteum are widely and deeply inflamed, in another the viscera, in another the nervous system, and in another the arteries. No reason can be given for these variations in the manifestation of the syphilitic poison except by saying that the stress of the disease falls upon the least resistant form of connective tissue in each person. Lastly, the iodides administered internally have a greater curative effect than the salts of mercury, though the two metals must often be combined to obtain the best results.

Pathology.—The gumma is as characteristic of the tertiary syphilis as the condyloma is of the second stage of the disease. A gumma appears as a new formation varying in size from a grain of wheat to a large tumour. It may be sharply circumscribed, it may be diffuse, or it may present radiating processes. It is always derived from connective tissue, and it consists microscopically of a delicate intercellular stroma filled with small round cells, and sometimes provided with newly developed blood-vessels. Some of the cells undergo further changes, becoming epithelioid and polynuclear, and though a gumma is very chronic, it sooner or later undergoes disintegration. The cells are subject to fatty degeneration, which causes the gumma to become purulent and discharge its contents externally. An ulcer is then left which heals and leaves a scar. In other cases the cells forming a gumma may disintegrate into a granular mass which is afterwards absorbed, or the cells may increase in size, fuse to form giant cells, which afterwards caseate—the whole gumma being absorbed without leaving any apparent trace, or causing any permanent injury to the physiological function of the organ in which it grew. More usually, however, this disappearance is less complete, for the gumma in its growth destroys the original tissue in which it grew, and when it has been absorbed, its place is taken by cicatricial tissue which may distort the tissue and materially impair its use. Very often, too, the growth of the gumma is associated with a new formation of connective tissue caused by the irritation to which it gives rise. This scar tissue interferes with the nutrition of the cells, which undergo caseation, and at the same time prevents their absorption, so that a hard fibrous nodule or mass is produced which may suppurate if it becomes infected with pyogenic organisms. The central mass of caseating material is then extruded, and an ulcer with indurated edges remains.

The infectivity of tertiary lesions in syphilis is unknown. It is probable that the secretions containing cells from the earlier tertiary manifestations are capable of conveying syphilis, whilst those from the latest forms are inert.

VASCULAR SYSTEM.—The heart, arteries, and veins are all liable to be affected by the syphilitic poison, for both contain abundance of connective tissue.

Heart.—Gummata of the heart have been repeatedly observed, and they attain their largest size in the ventricular septum. Syphilis also gives rise to a fibrous myocarditis and to an endocarditis which may attack the lining membrane of the heart, to a thickening of the valves, or to an inflammation of the coronary arteries. The pericardium is rarely affected without coincident inflammation of the heart itself.

The symptoms are broadly those of myocarditis due to the more usual causes. The patients often die suddenly, and the syphilitic lesion may only become manifest at the post-mortem examination, for the heart is affected late in the course of syphilis when no history of the disease is attainable. The diagnosis, therefore, is rarely made, but in a few cases recovery is said to have occurred under appropriate treatment.

The arteries are affected by syphilis in several ways. There may be a general arterio-sclerosis, which is either diffuse or nodular; an endarteritis, which may be obliterating or gummatous; a hyaline or amyloid degeneration of the arterial walls; or an aneurysm. It is probable that many syphilitic manifestations in the arterial system as well as in other parts of the body are *parasyphilitic* (p. 35), that is to say, they are only due indirectly to syphilis. These tissues have shared in the general syphilitic poisoning to which the whole body has been subjected. They have been weakened, and they have thus become more liable to disease, which in the ordinary course of events would have affected them, but perhaps to a less extent or from which they might have wholly escaped. The aorta, the cerebral arteries, the radial, the temporal, and the popliteal are the vessels most often affected; and in the smaller arteries the proliferation of the endothelial cells may be so great in syphilitic endarteritis as to cause complete obliteration of the lumen, but without any atheromatous degeneration.

Veins.—The veins are subject to a syphilitic phlebitis or periphlebitis which may attack the superficial veins of the arms and legs, or may even involve so large a vein as the common femoral. The plugging is not painful, and there is rarely evidence of acute inflammation.

The result of these syphilitic changes in the blood-vessels is to produce marked disease of the brain when they occur in the cerebral arteries, and to cause gangrene when they involve the vessels of the limbs.

The prognosis is not very good, because the symptoms are often indicative of advanced disease of the vessels in which they occur.

BONES AND JOINTS.—Syphilitic lesions of the bones and joints are numerous and characteristic, and they occur during each of the three main stages into which syphilis is divided for descriptive purposes. Neuralgia over the large joints relieved by mercury is of no uncommon occurrence during primary syphilis, especially in those who live in damp and warm climates. Bone pains known as osteocopic are of frequent occurrence during secondary syphilis, but it is not until the tertiary stage that the full force of the disease falls upon the osseous system.

Bone is divided for pathological purposes into an inorganic portion of no interest, and a living organic part, which includes the marrow and endosteum, extends through the whole thickness of the bone and terminates with the outer layer of the periosteum. This living tissue is alone capable of inflammatory changes, and the whole of it is involved though the changes may be more marked at one part than another, so that the inflammation can be divided clinically into periostitis, osteitis, or osteomyelitis.

Local periostitis, especially as it occurs on the shins, is so common and well recognised as a sign of syphilis that its old name *node* has passed into folk-speech. But nodes are not confined to the tibia, for they may be found on all bones lying subcutaneously, and thus exposed to injury. Both long and flat bones are attacked, so that nodes are found upon the skull as well as on the bones of the arms and legs.

The tumours formed by this form of syphilitic periostitis are ill-defined swellings, adherent to the bone, over which the skin moves easily unless they are inflamed. Nodes are tender and are often more painful at night than when the patient is following his occupation during the day. Treatment with iodides causes the localised periostitis to undergo resolution; but in some cases when the patient is unhealthy, and when the inflammatory process becomes infective, the nodes suppurate, an ulcer is formed, and there may be some necrosis of the affected bone.

Osteitis and Osteomyelitis.—It is impossible to distinguish pathologically between osteitis and osteomyelitis, though the periostitis is often sufficiently localised in syphilis to enable it to be classed separately.

In long bones the gummatous inflammation may be either localised or diffuse. When it is localised it may cause sufficient rarefaction of the bone to allow of its being broken by a slight injury—"spontaneous fracture." More usually, however, the inflammation affects the entire bone, which, in process of time, may become thickened, heavier than usual, and bent, so that it may be mistaken for a case of osteitis deformans. Suppuration is rarer in syphilis than in tubercle, and necrosis is consequently less common.

Dactylitis is one of the less common forms of syphilitic osteomyelitis. The affected phalanges increase in size and the skin becomes glazed, but it does not ulcerate unless the inflamed tissues become infected with pyogenic organisms. There is another form of syphilitic dactylitis in which the inflammation appears to start in the subcutaneous tissue rather than in the bone itself.

Bones containing an abundance of cancellous tissue are especially liable to syphilitic osteomyelitis. Thus there is a syphilitic spine just as there is a tuberculous spine—though it is commoner in the cervical than in the dorsal region,—whilst the bones of the head and face are well known to be particularly susceptible to syphilitic disease. The resulting deformities are often of very serious import to the patient, for the whole character of his face may be altered by the loss of the bridge of his nose, whilst a marked alteration in the voice may be produced by a syphilitic ulceration of the hard palate.

Soft nodes occur on the vault of the skull as a result of a gummatous infiltration, which is laid down between the bone and the dura mater on the inner side, or between the bone and the pericranium on the outer side. Progressive absorption takes place, and the whole thickness of the bone may be removed; more often only the external or internal plate is disintegrated by a process of serpiginous infiltration, the result of the fusion of several circular gummata. The scalp feels boggy over the affected parts, and occasionally pulsation is felt where the bone is perforated. It is not usual for suppuration or necrosis to occur, and the softened spots should not be incised with the idea of letting out pus.

The joints are less often affected in tertiary syphilis than the bones. The best known forms are the gummatous synovitis, which somewhat resembles the allied tuberculous form, and a more advanced type of disease—chondro-arthritis—in which the articular end of the bone is removed by a gummatous ulceration, leaving a thin membrane, representing the cartilage, over the ulcerated surface. Both forms of disease are very chronic, and the gummatous synovitis, so far as I have seen it, may be distinguished from the tuberculous form by the comparative absence of pain, and by the readiness with which the patient can use a joint which is apparently seriously disorganised. Chondro-arthritis may occur in many joints, and it may be associated with extensive gummatous periostitis.

The prognosis is good during the earlier stages of syphilitic inflammation of the bones and joints, but when the lesions are of long standing there is no remedy which will cause the reabsorption of scar tissue or the rarefaction of sclerosed bone. Plastic operations on the face to remedy the ravages of syphilis should not be lightly undertaken, but if there is no active ulceration an attempt may be made to remedy a defective bridge to the nose by the subcutaneous injection of paraffin, whilst holes in the palate may be closed by the resources of the dentist's art.

BURSÆ.—The out-patient room of every general hospital in a large town will show cases of gummatous inflammation of the bursa patellæ, or of that at the insertion of the ligament patellæ; but though these are the usual bursæ to be affected, similar enlargements are found in the semi-membranosus, iliopsoas, olecranon, and trochanteric bursæ, as well as in those at other parts of the body. The enlargement is painless, and is unaccompanied by inflammation, unless as a result of injury. The bursa is either hard or quite elastic. It gradually becomes adherent to the skin, and a typical gummatous ulcer is formed, which will heal readily enough, if it be kept clean, under the influence of a course of iodides.

THE EYE AND ITS APPENDAGES.—The eye suffers frequently and severely from the effects of tertiary syphilis. *The eyelids* may be the seat of gummatous ulceration and the conjunctiva of a chronic catarrhal inflammation. A localised gumma of the conjunctiva which may involve the sclerotic is not uncommon. It may ulcerate and leave a scar.

Iritis with its sequelæ is at once the most common and the most troublesome manifestation of tertiary syphilis. Its symptoms and appropriate treatment have already been indicated (p. 15). The danger of its subsequent complications is due in part to the inflammation involving the ciliary body and the choroid; in part to the continued irritation produced by the presence of synechiæ, which are adhesions between the edge of the iris and the anterior layer of the lens capsule.

Cornea.—The cornea is sometimes marked by small dots of different sizes, which are situated on its posterior surface—punctate keratitis. The dots are often arranged like a cone, with the apex at the margin of the pupil. The condition is due to the fluids of the eyeball circulating through the pupil, and bringing with them epithelial deposits and cells, which are deposited upon the posterior surface of the cornea. Keratitis punctata, therefore, is sometimes a symptom of iritis and cyclitis. But in addition to this there is a true syphilitic parenchymatous inflammation of the cornea, which is not associated with iritis, and which disappears gradually and entirely under constitutional treatment.

Cyclitis.—An attack of iritis may pass on into, or may be associated with, inflammation of the ciliary body, which is known as cyclitis. The symptoms consist of a deep circumcorneal zone, great pain of a neuralgic character, diminished intraocular tension, and marked interference with vision, for the media of the eye are hazy. The condition is rarely limited for any length of time to the ciliary body, but it soon spreads over the whole uveal tract or pigmented tissue of the eye.

The treatment of cyclitis is practically the same as for iritis, but iridectomy is required if the iritis recurs and synechiæ are present.

Choroiditis occurs in two forms, acute and chronic. Acute choroiditis is met with at an earlier period in syphilis than the chronic or disseminated form. It is often associated with retinitis, the patches of exudation being small, yellowish in colour, and situated near the periphery. The vitreous is cloudy and hazy and the pupil is dilated.

The patches of inflammation in disseminated choroiditis are scattered over the fundus of the eye, though they are especially numerous at the periphery. Both eyes may be affected, and as the symptoms are less marked than in the acute form, the changes are often far advanced when the patient first comes under skilled observation. There is then more or less extensive atrophy of the pigment-cells, though the sight is often fairly good until the central portion of the fundus is involved.

The treatment of choroiditis is essentially the same as that recommended for syphilitic iritis, atropine being most useful in the acute form of the disease. A course of mercury may be prescribed in the chronic form, to be followed by the administration of iodide of potassium, sodium, or ammonium. The condition of the vitreous sometimes gives a clue to the value of the treatment adopted, for it may become more translucent in the favourable cases, whilst at other times it maintains its opacity or flakes.

Retinitis, unassociated with choroiditis, occasionally occurs in the later forms of syphilis, leading to a diminution of central vision, with hemeralopia, in which the vision fails rapidly as twilight increases, until patients are practically blind in subdued lights. The patient may complain of subjective flashes of light, or of vibrating or rotating spots of light. The details of the fundus in the affected parts are hazy, the disc looks hyperæmic, and there may be retinal hæmorrhages.

The prognosis is good if the constitutional treatment be thoroughly carried out.

Syphilitic inflammation of the motor nerves of the eye, and of the optic nerve itself, are well recognised conditions, but as a result of intracranial rather than of intraocular causes, though occasionally a periostitis of the orbital plate will give rise to symptoms of papillitis or of squint. In the majority of cases, however, the third, fourth, or sixth nerves are involved in a gummatous inflammation of the dura mater as they pass through the foramina at the base of the skull. The sixth nerve is most often affected by inflammatory changes at the base of the brain, because it has the longest course on the floor of the skull. More rarely the nuclei of the nerves in the brain may be affected as a consequence of endarteritis of the cerebral vessels, and still more rarely there may be a gumma of the cerebral substance itself.

Diplopia is the most marked feature of the paralysis, and according to the character of the double vision it is possible to distinguish the weakened muscle, and consequently the nerve affected. When the paralysis attacks the third nerve the upper lid droops, the pupil is dilated, and the eye looks outwards (exophoria) with crossed diplopia. Paralysis of the sixth nerve causes an internal squint, and there is homonymous diplopia. When the fourth nerve is involved the patient complains of a diplopia in which the two images are inclined towards each other at their upper or lower ends, and the position of the images causes him especial trouble in such an action as walking down stairs.

Mr. Hutchinson some years ago described an interesting condition to which he gave the name of ophthalmoplegia, in which all, or nearly all, the external muscles of the eye are affected with a paresis, which may develop later into complete paralysis. The disease is usually associated with syphilis, and is always due to a lesion situated below the aqueduct of Sylvius, so that it involves the oculo-motor nerves. The nuclei of the ciliary muscle and of those of the iris escape, because they are situated farther forwards, and have a different blood-supply.

The symptoms are ptosis or drooping of the upper eyelid, with limitation of the movements of the eye in every direction, but more especially upwards. There is neither loss of accommodation nor paralysis of the iris.

Optic Neuritis.—Syphilis causes a papillitis in the same manner as it produces a paralysis of the oculo-motor nerves. The papillitis is usually a late manifestation of the disease, and it either runs a chronic course with but little impairment of vision, or it is acute with rapid loss of function on the part of the optic nerve.

The treatment of each form of syphilitic neuritis is a sufficient course of iodides. The prognosis need not be too gloomy, for the gummatous inflammation to which it is usually due often subsides, and the nerves then resume their function.

The lachrymal apparatus may suffer disturbance as a result of displacement of the puncta owing to facial paresis; to stenosis of the nasal duct due to inflammation spreading from the bones forming the nose; or from abscesses in connection with the duct itself. The patient suffers from epiphora or watery eye, which needs the treatment usually adopted in non-syphilitic forms of this condition, with removal of any diseased bone which may be present. Iodides will prove indispensable.

THE EAR.—The external ear is not particularly subject to gummatous ulceration. The middle ear is most frequently affected in patients who are suffering from syphilis, owing to the extension of the inflammation from the nasopharynx. Simple catarrh and suppurative inflammation are common during the secondary stage of the disease, whilst labyrinthine disease may lead to early and complete deafness, bone conduction being diminished from the first appearance of symptoms.

Syphilitic inflammation of the middle and internal ear runs a chronic course, and the prognosis is not very good. Mercury combined with the iodides, as well as the ordinary local treatment, may help the patient.

THE NOSE.—The tertiary lesions of the nose are very offensive and disfiguring. The septum nasi becomes ulcerated, and may eventually be perforated; the cartilages are especially liable to share in the inflammatory process; but in many cases the bones are widely involved, and if the vomer be deeply implicated the bridge of the nose may fall in, causing a characteristic flattening, whilst if the cartilaginous portion is involved the tip sinks and becomes flattened. Occasionally the whole substance of the nose is disintegrated, so that the nostrils are only represented by cicatricial openings. The destruction is usually a carious change; but the bone may undergo necrosis, and may be exfoliated in large pieces. The syphilitic inflammation sometimes extends to the superior maxilla, the ethmoid, sphenoid, the lachrymal bones, and even to the basi-occipital. The carious process is associated with a most stinking and abundant discharge, and with the formation of dark-coloured crusts, whilst the absorption of the poisonous products in the more severe cases leads to much cachexia.

The prognosis is fairly good in the slighter cases of syphilitic rhinitis, as the symptoms are often relieved by constitutional remedies; but it is more serious when there is evidence of caries.

Treatment.—A spray consisting of sod. bicarb. grs. xv., acid. borici gr. xv., acid. carbol. grs. iv., glycerini ♏45, et aquam ad ℥i., will often be found useful in the slighter cases of ulceration, but for deep and spreading ulcers the application of solid nitrate of silver is necessary, whilst an insufflation of iodoform powder will often assist in the healing process. Any dead bone which is loose should of course be removed, and in the worst cases careful scraping with a sharp spoon is advantageous.

MOUTH AND THROAT.—The mouth and throat are both subject to various manifestations of late syphilis.

The tongue in particular is affected more in men than in women, and more in smokers than in those who do not smoke. The surface of the tongue presents numerous patches of altered epithelium which are at first separate, but which in time fuse together. The altered epithelium may either be thrown off, leaving the papillæ bare and raw, or it may increase in thickness, and form dry patches which become fissured. A similar condition of leukoplakia is found on the buccal mucous membrane.

The treatment consists in the administration of potassium iodide, the absolute prohibition of smoking, and a careful attention to any irregularities in the teeth which may cause irritation. The local application of chromic acid, grs. x. ad ℥i., or of hyd. bicyan. grs. xv. ad ℥i. is serviceable. There is some reason to believe that the epithelial changes may progress or may be converted into epithelioma of the tongue in persons who are otherwise predisposed to cancer, and it is wise therefore to arrest the irritative process as soon as possible.

Gummata occur on the tongue and palate in a considerable number of cases, and may lead to extensive destruction by the degenerative changes which they undergo. Gummata on the tongue may be small, numerous, and superficial. They break down readily, causing small ulcers which show a serpiginous tendency. More usually the gumma is single, and lies in the connective tissue between the muscular fibres. It is usually situated far back on the dorsum of the tongue; it is painless at first, but it soon breaks down to form a small ulcer with well-defined edges.

The gummatous ulcer must be distinguished from an epitheliomatous ulcer, which is frequently grafted upon it, and from tuberculous ulceration of the tongue. The epitheliomatous ulcer is usually situated at the edge of the tongue, and the ulcer is not excavated whilst the neighbouring lymphatic glands are affected. A simple gumma heals when iodides are administered, whilst an epithelioma only improves for a few days under this method of treatment. Tubercle affects either the base or the tip of the tongue, and the ulceration is much more extensive than either the syphilitic or cancerous form. Gummata of the palate ulcerate with extreme rapidity, and a perforation is soon formed. When the hard palate is attacked, the anterior portion is generally affected; in the soft palate the pillars of the fauces often bear the brunt of the ulceration.

The treatment consists in the administration of iodides, with the addition of mercury if the patient has not already had a course.

LARYNX.—The later manifestations of syphilis in connection with the larynx are ulceration, gummata, and subsequent cicatrisation with its attendant evils. The epiglottis suffers most, and the upper surface is more often attacked than the under aspect. The ulceration may occur on any part of the laryngeal mucous membrane, however, for the aryteno-epiglottidean folds, the arytenoid cartilages, and the vocal cords, true and false, are affected. The ulceration is usually deep and destructive, involving the muscles, the perichondrium, and the cartilage; but it sometimes remains superficial, with a remarkable tendency to relapse.

Symptoms.—The patient complains of hoarseness, dyspnœa, and perhaps pain shooting up to the ears. There may be great dysphagia with symptoms of œdema of the glottis, which may be so urgent as to require immediate tracheotomy or laryngotomy.

The condition has to be distinguished from tuberculous and cancerous ulceration. In syphilis the ulceration develops more rapidly than in tubercle or cancer. The ulcer is often single at first, and unilateral, deep, and irregularly oval in shape. In phthisis the progress of the ulcer is slow, and the mucous membrane is pale. The under surface of the epiglottis is most often affected, and the ulcers are numerous, bilateral, small, and round. In cancer the ulcer is preceded by the formation of a new growth, and there are nearly always nodular excrescences upon or around the solitary ulcer.

The prognosis is satisfactory as regards life, except in the cases where there is much perichondritis of the thyroid and cricoid cartilages, when death may ensue from acute œdema or from extensive suppuration.

The treatment consists locally in touching the ulcerated surfaces with a solution of sulphate of copper (15 grains to the ounce), or by the inhalation of an atomised solution of perchloride of mercury (1 : 1000); iodoform too is sometimes serviceable. A spray of carbolic acid (1 : 40) or of thymol may be used if the breath is foul-smelling. The œdema of the glottis must be treated upon the ordinary lines by scarification.

VISCERAL SYPHILIS

TRACHEA AND LUNGS. — The trachea is usually involved in syphilis by direct extension of the laryngeal inflammation, and may be followed by a very great narrowing of the lumen either along the whole tube or in its lower third.

The question of lung syphilis in adults has been the subject of much controversy. Gummata and an increased amount of connective tissue are unquestionably found in the lungs of patients who have died with other signs of syphilis. The sclerosis is found at the lower and middle lobes rather than in the apices, and it is said that the suspicion of syphilis should always attach to lesions beginning in the lower parts of the lungs and slowly progressing without the production of fever.

THE ALIMENTARY TRACT.—With the exception of the mouth and rectum, the alimentary tract is but rarely affected by syphilis in its acquired form.

The Rectum is liable to gummatous ulceration, or to a definite fibrous infiltration beginning in the submucous tissue, and leading secondarily to ulceration of the mucous membrane, and finally to stricture.

Gummata formed in the rectum give rise to no particular symptoms until ulceration has occurred, when the patient notices that he has pain, increased after defecation, with spasm, a sero-purulent or mucous discharge, and attacks of constipation alternating with diarrhœa. Cicatrisation may take place, or an abscess may form, which ends in a fistula.

A rectal examination shows that the ulcer is generally situated within two inches of the anus, and may involve the entire circumference of the bowel. The prognosis of gummatous ulceration is that it will heal under a course of iodides, but that some amount of stricture is almost sure to follow if the ulceration has been extensive and deep.

Fibrous infiltration, or *ano-rectal syphiloma,* is much more unsatisfactory. It occurs in women more often than in men, and syphilis, I think, is only one factor in its production. At first there are no symptoms to call attention to its existence, though a digital examination, made perhaps for some other purpose, will reveal a thickened, leathery, inelastic condition of the rectal wall extending from three to five inches from the anus. A superficial ulceration of the mucous membrane occurs after a time, and extends for some distance above the indurated wall of the rectum. It is very painful, bleeds easily, secretes pus, and causes diarrhœa.

Treatment.—The gummatous ulceration is more or less amenable to the ordinary course of iodides, coupled with a thorough scraping of the ulcerated wall in advanced cases. The indurated condition appears to be hopeless when it has once obtained a firm hold of the patient. Neither mercury nor iodides are of the least service, and in the last two or three cases which have been under my care, the patient has been glad to submit to an inguinal colotomy, which has relieved her of pain and of the distressing diarrhœa, whilst it has lessened the amount of the discharge from the bowel.

Stricture of the rectum may be dilated by the use of a rectal bougie, or it may be divided *in situ* and afterwards dilated. A modification of Kraske's method is serviceable in some cases; it consists in first performing an inguinal colotomy, and then removing the strictured bowel after excising the coccyx. The colotomy wound can afterwards be closed.

THE LIVER AND SPLEEN.—The liver and spleen are more rarely affected in acquired than in hereditary syphilis, but inasmuch as both organs contain a large amount of connective tissue, they are subject to the inflammatory processes characteristic of late syphilis.

The liver may be generally inflamed so that it is affected with a chronic interstitial hepatitis, or it may be the seat of gummata. In the chronic interstitial hepatitis, which leads to cirrhosis, the capsule of Glisson becomes thickened and adherent to the surrounding structures. The new connective tissue is less evenly distributed than in alcoholic cirrhosis, and the liver is consequently lobulated in an irregular manner; the lobes being separated by deep depressions due to the contraction of the scar tissue. The process is usually very chronic, but the pain is sometimes severe. It may be associated with amyloid disease or with albuminuria.

Isolated gummata are sometimes a more marked feature of hepatic syphilis than the cirrhosis just mentioned. They are found either as elevations beneath the capsule, or deeply in the substance of the organ; in the latest stages depressed scars may show where they have been replaced by fibrous tissue. The symptoms are often obscure, especially if the gummata are few and small. Ascites is somewhat less marked than in other cases of hepatitis, and there is sufficient evidence of syphilis in other organs to warrant the diagnosis.

The prognosis is not very good, but the administration of iodides must be persisted in, and they may be usefully combined with sarsaparilla.

The spleen is affected in the same manner as the liver, but much less often. The inflammation is either diffuse or localised. In the early stages of the diffuse forms the spleen is enlarged, and in this stage I have seen it become movable; in the later stages it shrinks and becomes denser than usual. The gummata vary greatly in size and number. They may go on to cicatrisation, and may cause the spleen to become adherent to the diaphragm. The splenic inflammation does not give rise to any symptoms of importance, and in the absence of other evidence of syphilis it would probably pass unrecognised.

THE GENITO-URINARY ORGANS.—*The kidneys* have been found to contain gummata from time to time, and syphilitic people suffer occasionally from the symptoms of large white kidney, but very little is known of the relation of syphilis to renal disease.

The genital organs of both sexes may be subject to gummatous inflammation during the later stages of syphilis. In the male, gummata are found on the inner surface of the prepuce, and in the urethra close to the meatus; whilst in some cases a small induration is observed in one of the corpora cavernosa, which slowly and painlessly increases in size until it seriously interferes with the function of the penis as an erectile organ. In women gummata occur in the labia, and near the inferior commissure of the vagina. More rarely they have been recognised in the vagina, where they may cause much ulceration, and have produced a recto-vaginal fistula.

The ovaries are subject to diffuse inflammation, leading to the formation of fibrous tissue. Very little is known of uterine disorders as a result of syphilis.

The testes are especially liable to inflammatory attacks as a result of syphilis. Two forms of orchitis are easily recognised during the later stages of syphilis, the smooth oval swelling and the craggy sarcocele. Either form of inflammation may be associated with a hydrocele, in some cases of the tunica vaginalis, and in others of the seminiferous tubules.

The testicle enlarges slowly and painlessly in the diffuse inflammation, maintaining its shape, but early losing sensation. The enlargement is succeeded in process of time by contraction of the newly-formed fibrous tissue, with eventual atrophy of the gland. The vas deferens remains unaffected, the prostate and the vesiculæ seminales are not enlarged, and the differential diagnosis is thus made between syphilitic and tuberculous orchitis. In the craggy sarcocele the testis is the seat of gummata which lead to an increase in the size and irregularity in the shape of the testicle. The gummata may break down to form an abscess which opens by one or more openings through the scrotum, and in some cases leads to the formation of a hernia testis.

The prognosis is good in cases of syphilitic disease of the testicle. The reproductive power is not lost in the early stages, even when both glands are affected; but when atrophy has occurred the patient is sterile. Local and constitutional treatment is of the utmost benefit even when the inflammatory changes have advanced to a marked extent, for testicular inflammations appear to be more amenable to mercury and the iodides than those of any other organ except the skin.

The treatment consists in putting the patient at once upon a thorough course of iodides and strapping the affected gland with Scott's dressing. No operative measures should be recommended, for even in the worst cases the conditions rapidly improve under appropriate treatment.

SKIN ERUPTIONS.—Rupia is the name given to a characteristic eruption on the skin which appears late in the secondary or early in the tertiary stage of syphilis in people who from any cause are broken down in health. A red spot, marking an infiltration of the cutis, first appears, which afterwards suppurates, and a round pustule is formed, the superficial layer of which dries up into a scab. The suppuration continues beneath the scab, and involves more of the surrounding tissue, which in turn scabs, so that a series of concentric rings are formed, of which the central ones are thicker and higher than the outermost. The accumulation of scabs thus resembles a cone with a flat base, which has been aptly compared with a limpet shell.

The treatment is by the internal administration of mercury combined with the iodides and the local application of iodide of starch, which is made by boiling together one ounce of powdered starch, two ounces of glycerine, and six ounces of water, an ounce of solution of iodine being added when the mixture is nearly cold.

The true tertiary skin eruptions in syphilis consist of an infiltration of the skin and deeper subcutaneous tissues with gummatous material, which afterwards softens, suppurates, and ulcerates, so that it always leaves scars, and may be extremely painful.

Gummata situated superficially in the skin show a tendency to ulcerate in a serpiginous manner, a part of the ulcer healing in one direction whilst it extends in another, so that the ulcerated surface presents an appearance like a snail-track. The leg is more often affected than any other part of the body, and next in order of frequency come the forearm and thigh, the neighbourhood of the joints showing an especial liability to ulceration, though the scars do not afterwards hamper their movements.

Gummata are also found, but less commonly, in the subcutaneous tissue, where they give rise to very chronic and troublesome ulceration. Such deep-seated gummata usually occur on the inner surface of the forearms and arms, on the breast, and on the legs. They are not of uncommon occurrence upon forehead and scalp, where serious destruction of the tissues may ensue, even to perforation of the bone (p. 25). Gummatous ulceration is to be distinguished from lupus by the fact that it occurs in older people, that it shows a much greater tendency to suppurate, and that there is other evidence of syphilis. Cases have occurred in which glanders, actinomycosis, and leprosy have been mistaken for syphilitic eruptions.

The treatment in the ulcerating forms consists in the application of fomentations of biniodide of mercury, 1 in 1000, or of black wash, until the suppuration has ceased and the ulcer presents a healthy appearance, when the healing may be completed by the application of boracic ointment. A mixture containing perchloride of mercury and iodide of potassium should also be ordered for the patient.

Muscles and Tendons.—The muscles are affected in syphilis either directly or secondarily through the nerves supplying them. The primary lesions assume the form of an inflammation of the connective tissue in the muscle, either localised as a gumma or diffused throughout the muscle. The flexor muscles of the forearm, the biceps, the pectoralis major, the sterno-mastoid, the masseter, and the rectus abdominis are perhaps more often affected than the other skeletal muscles. In the diffuse inflammation the muscle becomes uneven, shortened, and irregular in outline. In the gummatous form one or more tumours can be felt in the affected muscles, usually near their tendons. The growth at first moves with the movements of the muscle, and can be felt more readily during relaxation than during contraction; but the attendant inflammation soon attaches the muscle sheath to the surrounding tissues, and there is then interference with the movement of the muscle.

Early treatment is advisable, as the inflammatory changes can then be arrested; but as the myositis often causes but little pain or inconvenience the patient may not seek advice until the gummata have begun to break down, when deep and troublesome ulcers may be formed.

The synovial sheaths of the tendons are liable to a gummatous inflammation in the later stages of syphilis, the tendo Achillis, the biceps, and the flexor and extensor tendons of the wrist being most frequently affected.

The local treatment consists in strapping the affected part, and limiting the movement in the muscle to which the tendon belongs.

Bursæ, like tendons and muscles, are the seat of a gummatous inflammation, which is sometimes symmetrical, as when both the prepatellar bursæ are enlarged. The inflammation may begin in the bursa or it may spread from the surrounding tissues. Troublesome ulcers are produced if the bursæ are left untreated, and when they are subject to irritation; but the inflammation usually subsides under a course of iodides if the bursa be kept clean.

THE NERVOUS SYSTEM.—The later manifestations of syphilis in connection with the nervous system are severe and far-reaching. They depend, as in other parts, upon the production of inflammatory new tissue, which has a tendency to undergo degenerative changes at first and afterwards to be replaced by scar tissue. The anatomical peculiarities of the central nervous system lend certain features to these changes which differentiate them from similar changes in other parts of the body. In the first place the progress of the disease cannot be estimated until definite signs are produced, since evidence derived from sight and touch is necessarily excluded. The peculiarities of the terminal blood-supply and the fact that the cells of the nervous system do not reproduce themselves render comparatively slight anatomical changes of great functional importance. Syphilitic inflammation affects the central nervous system in the same way as it involves other parts of the body. Gummata more or less localised may spring from the pia mater of the brain or spinal cord. A diffuse inflammation may involve the dura mater or the pia mater, compressing the nerves and leading to the fibroid thickening known as spinal pachymeningitis. The arteries may be thickened and so diseased that the blood clots as it passes through them, or the scar tissue which is formed yields to produce an aneurysm. More rarely one of the arteries within the brain substance gives way, and the patient dies of cerebral hæmorrhage. Apart from these well-recognised conditions resulting from syphilis, there is reason to think that some forms of myelitis, and certain scleroses of the cord, such as those producing locomotor ataxy, are more or less directly connected with syphilis.

CEREBRAL THROMBOSIS.—The disease of the cerebral arteries manifests itself chiefly by an attack of hemiplegia, due to the blocking of one of the cerebral arteries, most often the Sylvian. The attack comes on in those who are as yet too young for atheroma due to senile changes, viz., under forty-five, and without obvious cause, *i.e.* where there is no valvular disease of the heart and the patient has never suffered from any condition likely to produce endocarditis. The onset is sudden, and is seldom attended by loss of consciousness. It is often preceded by severe headache, which is either general or is felt chiefly on the side of the head which will be affected. The pain may only be felt for a few days or a week before the attack, or it may last much longer. Occasionally a slight tingling or other sensation is felt for a day or two before the onset upon the side which is to be affected. The onset therefore, although it is rapid, is not quite so sudden as when a small aneurysm on a cerebral artery gives way and blood is poured into the brain tissue. The loss of power, though it is limited at first, usually spreads to a greater or less extent, because the fibres in the large nuclei of the brain, especially in the internal capsule, which is usually affected, are packed together very closely.

Prognosis.—The attack is followed by the usual effects of cerebral thrombosis, owing to softening and destruction of the brain tissue, but the prognosis is rather better than the severity of the symptoms at the time of onset would otherwise warrant. Recovery follows the ordinary rule that the leg first regains its power, the face next, and the arm with its especially complicated movements last. During the attack the wrist, elbow, knee, and ankle reflexes are increased. The faradic response remains normal throughout the entire period of paralysis, and contractures are likely to occur though there is no appreciable atrophy. Aphasia in some of its various forms is not uncommon.

The treatment consists in relieving the progress of the arterial inflammation by the administration of iodides. As soon as the immediate symptoms have passed off, the patient should be shampooed to prevent the occurrence of contractures during convalescence.

Diffuse gummatous inflammation affects the meninges and cortex of the brain, and although it is diffuse it often presents patches of more intense inflammation, which makes it possible to localise the condition.

The symptoms come on gradually, and do not differ materially from those which characterise a meningitis due to other causes,—headache, stupor, increasing coma, and perhaps localised convulsive attacks—Jacksonian epilepsy—if the motor area be involved. In many cases one or more groups of nerves are involved as they leave the dura mater, so that various paralyses occur, some of which have already been mentioned in connection with the syphilitic affections of the eye (p. 27).

Gummata, as the more localised products of syphilitic inflammation, cause definite symptoms which enable their position to be detected with considerable accuracy. Like many other forms of cerebral tumour they may give rise to an optic neuritis.

SPINAL CORD.—The changes which occur in the brain as a result of syphilis take place too in the spinal cord, but in the spinal cord the meningeal inflammation is of greater importance than the arterial changes. The meningeal inflammation may begin in the membranes of the spinal cord, or it may be secondary to syphilitic disease of the vertebræ. The meningitis is often limited, and the symptoms consequently vary with the part affected, the higher the lesion in the spinal cord the more extensive being the disturbances produced.

PERIPHERAL NERVES.—The sensory and motor nerves of the body contain considerable quantities of connective tissue, and they are in consequence no more exempt from syphilitic inflammations than other parts. The local neuritis manifests itself in various forms of neuralgia and sometimes in actual diminution of sensation, whilst paresis of one or more groups of muscles has been observed from time to time.

PARASYPHILIS.—Reference has already been made (p. 24) to certain conditions in which mercury and the iodides have no remedial power though syphilis appears to be the predisposing, if not the actual, cause of the condition for which these drugs were administered. It has long been supposed that tabes and general paralysis bear some relation to syphilis, and Dr. Mott has recently brought forward a considerable body of evidence to show that in a large number of cases syphilis forms a preponderating element in their causation. In the same manner Dr. Fournier has shown that some forms of neurasthenia and hysteria are produced indirectly by syphilis. Dr. Fournier has also called attention to the peculiar condition of the skin known as *the pigmentary syphilide*, which may be mistaken for vitiligo or chloasma. The condition is found in women more often than in men, in the form of pigmented spots, patches, or networks found usually on the side of the neck, though it may occur in other parts of the body. The colour varies from a light to a deep brown, and in some cases the affected surface is covered with white specks which may lead to an erroneous diagnosis of leucoderma. Inunction with mercury may prove serviceable in removing the discoloration, but neither mercury nor iodides administered by the mouth have any apparent effect upon the pigmented patches.

TREATMENT OF TERTIARY SYPHILIS.—Pathology indicates the causes of the varying action of mercury and the iodides in the earlier and later stages of syphilis; but until the pathological life-history of syphilis is fully told, the whole truth must remain hidden. It would appear that so long as the syphilitic poison is being generated in the affected body and is giving rise to actual changes in the connective-tissue elements, so long is mercury effective, for it limits the output of poison and may actually arrest its manufacture. Mercury, therefore, must always be given in the earlier stages (p. 17). Chronic inflammation in the connective tissues is due to the action of the syphilitic poison, and the inflammation in each individual falls with greatest intensity on the connective tissue in his weakest part. In some persons, therefore, the arterial system suffers most, in others the osseous system, and in others, again, the nervous system or the deeper layers of the skin. The chronic inflammation of the connective tissues may continue when it has once been started, even in the absence of fresh syphilitic poison. The iodides possess the power of causing absorption of this new and imperfect connective tissue, so long as it is cellular in character, since they have no action upon fully formed fibrous or scar tissue. This power of absorption is not limited to syphilitic fibroid tissue, for it is manifested in other forms, as in cancer and actinomycosis. The term absorption is merely a convenient one, because as yet we do not know how the iodides act upon the newly-formed connective-tissue cells to cause their disappearance. From time to time the tissues appear to regain the power of manufacturing fresh supplies of syphilitic poison, and it is sometimes advantageous to give mercury and iodides together. For this purpose the draught known at St. Bartholomew's Hospital as Paget's mixture is convenient and efficacious. It consists of liq. hyd. perchlor. one drachm; caramel, a sufficiency; iodide of potassium, five grains; and chloroform water, a fluid ounce. The draught contains about one-tenth of a grain of the red iodide of mercury, and is given three times a day. The iodide of potassium is usually given, but it may be advantageously replaced in many cases by iodide of sodium, or iodide of ammonium, or each salt may be combined with the others. A little carbonate of ammonium increases the good effects of the drug. The ordinary dose of the iodides is five grains, to be increased rapidly to ten or fifteen grains, three times a day. Much larger doses are sometimes required, so that patients are frequently ordered forty-five to sixty grains thrice a day, to be taken for long periods of time. In such cases it is convenient to administer the dose as a drink in some effervescing water to be taken just after each meal. The iodides seem to act more efficaciously when they are administered with large quantities of sarsaparilla—the essence of Zittmann's treatment (p. 22)—or with guaiacum. It should be clearly understood, however, that in Europe neither of these drugs has any curative effect upon syphilis at any stage, though guaiacum was used by the native races of America for the cure of syphilis, and from them was introduced into Europe in the fifteenth century as a reputed powerful anti-syphilitic. It has not, however, withstood the test of time or of advancing knowledge.

As mercury produces a series of symptoms known collectively as salivation from the most prominent sign, so the administration of the iodides may produce a train of symptoms called iodism. The most common symptoms of iodism are loss of appetite with gastro-intestinal disturbance, and a metallic taste in the mouth with coryza, lachrymation, tinnitus aurium, and a pustular eruption which in severe cases may be purpuric. A few patients present a remarkable idiosyncrasy, for minute doses of the iodides will produce these symptoms; whilst others can take large doses without showing any symptoms of poisoning.

The use of iodides should not be continued for an unduly long period, as there is reason to believe that the tissues become habituated to the presence of iodine. The course of treatment should be interrupted, therefore, from time to time, and the patient should be ordered a tonic mixture, containing iron and nux vomica or strychnia and dilute phosphoric acid.

Various sulphur baths have been highly extolled in the treatment of syphilis, the most frequented being those at Aix-la-Chapelle, Aix in Savoy, and Luchon. There is, however, no reason to suppose that these or any other baths can eliminate the syphilitic poison, though they may benefit the general health of the patient and thus put him into a better position to withstand its effects.

As a broad rule, a person who has had syphilis remains immune to the disease for the rest of his life, and this applies to individuals who contracted the disease during or just after their birth. In very rare cases reinfection may occur, either because the patient has been completely cured after the first attack, or because, for some reason as yet unknown, he is peculiarly liable to the disease.

Relation of Syphilis to Life Insurance.—There is no evidence to show that syphilis if it be well treated materially shortens the life of the patient. Dr. Salomonsen, who has recently considered the relation of syphilis to life insurance, thinks that the patient should be kept under observation for four or five years after the initial lesion; that the premium should be increased for the next four or five years; but that if the patient has been well treated and is in good health ten years after the date of infection, he may safely be passed at the ordinary rates for his age.

Syphilis in Children

A child may be born syphilitic because the disease was transmitted to it at the time of its conception, or because the mother was infected during the earlier months of her pregnancy. It may acquire syphilis at the time of its birth by passing along a recently infected puerperal tract, or it may become infected from extrinsic sources either shortly or at a more remote period after its birth.

Hereditary Syphilis, as its name implies, is derived from infection transmitted to the child from its father, its mother, or from both parents. It differs in many respects from acquired syphilis, and from a practical standpoint chiefly in the lesser power of transmitting the disease. In syphilis acquired at or shortly after birth it may be possible to obtain evidence of the seat of inoculation, but whether such evidence is or is not forthcoming the child is capable of transmitting the disease in the same way and by the same means (p. 5) as an infected adult.

Much interest has been aroused as to the means by which syphilis is transmitted hereditarily, but there seems to be no reasonable doubt that the semen of a man affected with syphilis in its earlier stages is capable of transmitting the disease to a healthy ovum at the time of fertilisation without infecting the woman who produces the ovum: conversely, a woman suffering from syphilis in its early stages will produce an infected ovum which may be fertilised by a man who is himself free from syphilis. In either case the product of conception may be syphilitic. But it is not necessarily syphilitic in the ordinary acceptation of the term, for clinical evidence shows that healthy children are sometimes born when one or other of the parents is suffering from syphilis in its active stage. These children are to a certain extent immune to syphilis, the immunity being conferred by the mother and not by the father. This fact was elicited by Guiseppe Profeta, and is now known as *Profeta's law.* He stated in 1865 that a healthy child born of a syphilitic mother could be suckled by her or by a syphilitic wet nurse with impunity. The immunity of such children is only temporary, however, and they may acquire syphilis later in life, and may then suffer as severely as those who have not been protected. In like manner a syphilitic child born of a mother who has shown no signs of syphilis will not infect its mother though it may transmit syphilis to other persons. This fact, known as *Colles'* or *Beaumès' law,* was recognised by Abraham Colles in 1837, who made the following statement:—"I have never seen or heard of a single instance in which a syphilitic infant (although its mouth be ulcerated) suckled by its own mother had produced ulceration of her breasts; whereas very few instances have occurred where a syphilitic infant had not infected a hired wet nurse, and who had previously been in good health." Both Profeta's and Colles' laws are somewhat too absolute, for, like all generalisations in pathology, exceptions have been observed from time to time.

There is no definite limit to the time when a parent is able to transmit syphilis to the child. It is usually said that five years after infection a father is unlikely to propagate syphilis, and that he is less likely to do so if he has undergone a mercurial course than if he has remained untreated. But cases are recorded where a syphilitic child has been born as long as twenty years after the father's inoculation, and it is notorious that syphilitic children may be born in spite of all treatment of the parents. It is advisable, therefore, to dissuade a man from marrying until the expiration of five years after infection, but as this advice will only rarely be taken, the general rule is to forbid a patient to marry until he has been free from any manifestation of active syphilis for at least three months. He should have been thoroughly treated with mercury (p. 17), and from the time of her marriage his wife should also be put upon a mercurial course.

Abortion or intrauterine death occurs in a considerable number of cases of inherited syphilis, and more often when the mother or both parents are affected than when the father alone transmits the disease. Abortion usually occurs about the sixth month, and somewhat later in each succeeding pregnancy in a woman who is well treated, both therapeutically and hygienically, until, in due course, a living and healthy child may be born. An examination of the still-born children will always demonstrate the presence of syphilitic lesions in the skin, viscera, bones, or nervous system. The fœtus is often macerated, the spleen and liver are enlarged, the intestines may be matted together by the products of an intrauterine peritonitis, and the bones may show evidence of epiphyseal inflammations.

Early Signs and Symptoms.—Children born alive with symptoms of inherited syphilis are often the subjects of gastro-enteritis, and from the beginning are but too often the "wasters," who are such familiar objects in the wards and out-patient rooms of every children's hospital. Such children show in a more advanced condition the various signs of syphilis found in the still-born infant. More often, however, a syphilitic child is well nourished at birth, and may remain in apparent health for a period of three weeks to two months, though examination of the spleen will usually show some enlargement. The baby then begins to pine until it may be so emaciated that the skin becomes loose and shrivelled, and it looks like a wizened old person. These children were some of the "changelings" of whom our folk tales are so full, and whose existence excited so great a horror amongst our ancestors that no baby was left unattended for a moment until it had been safely christened, a ceremony which was thought to place it out of the power of the good people.

Snuffles is one of the earliest signs of inherited syphilis. It is caused by a swelling of part of the mucous membrane of the nose, and is often considered to be merely a cold in the head. The condition is only important from a diagnostic point of view if other signs of syphilis appear, for it is easy to attach undue importance to this sign, and there is some tendency to put a baby on a course of grey powder when it has really only suffered from a nasal catarrh. The snuffles in syphilis lasts for a long time, and may cause some broadening at the root of the nose which may persist throughout life, but more often disappears with the growth of the face.

Skin.—A rash appears soon after the snuffles have been observed. It may be erythematous, papulo-squamous, or more rarely roseolous like that which is common in acquired syphilis. Dr. Radcliffe Crocker describes the rash in the following words:—"It consists of erythematous patches of various sizes, which usually commence on the buttocks and round the anus. They may be well or ill-defined at the edge, bright coppery or yellowish-red, tending to coalesce into large sheets of eruption, but generally patchy at the borders. This erythema may extend uniformly on the back and inner sides of the legs, quite down to the feet, including the soles, which are bright red and peeling. On the front and outer side it is still generally patchy, upwards it often extends to the loins and abdomen, and in a few cases all over the body in patches which coalesce; the whole surface is then red and desquamating on the dry parts, while on the buttocks, or where it is exposed to moisture, the scales are soaked off and the surface is left raw or brightly glistening. These generalised cases are very likely to die."

The papulo-squamous rash consists of round superficial patches slightly raised with a pink or reddish brown colour at first, which soon becomes of a pale fawn tint. It may be limited to one or more regions, such as the limbs, forehead, or round the mouth. But sometimes it occupies the whole surface of the body, usually in discrete patches, and occurs on the buttocks where superficial ulceration is apt to occur. Dr. Crocker also describes a crescentic squamous variety of this eruption as well as a vesicular form. Any of these rashes may become pustular, and bullæ are not uncommon on the palms and soles.

Bones.—The bones show various changes during the first six months in the life of a syphilitic baby. The most important and frequent are the epiphyseal changes in the long bones, which occur most often at the lower end of the femur, in the bones of the legs, forearms, and ribs; more rarely in the phalanges of the fingers and toes, where the condition is known as syphilitic dactylitis. The earliest epiphyseal change occurs in several bones, and is due to a proliferation of the cartilage cells with an increased calcification but delayed ossification. The proliferation of the cartilage cells interferes with the blood-supply, and the cells therefore undergo degenerative changes which result in the formation of a yellow or orange line in the intermediary cartilage, sometimes with separation of the epiphysis. This yellow degeneration may occur within the first week or two of life, and is often associated with periostitis. A little later, a child who has been born apparently healthy may show, within the first three months of its life, a gelatiniform degeneration of the intermediary cartilages. This form of degeneration affects the arm more often than the leg, and unlike the rickety deformity, is asymmetrical. It is sometimes associated with a condition of pseudo-paralysis, in which one or more of the limbs lie cold, wasted, and flail-like. The pseudo-paralysis is due to a myositis in some cases, and to a peripheral neuritis in others.

The bones of the skull are peculiarly liable to local periostitis during the earlier months of life in syphilitic children, the inflammation being often symmetrical, and occurring on the frontal and parietal bones close to the anterior fontanelle, where they form Parrot's nodes, and cause the skull to be described as "natiform" or "hot cross bun-shaped." Syphilitic children are often rickety, but there is no reason to think that the nodes here described are syphilitic rather than rachitic in origin. They usually disappear during the first year, and leave no trace of their existence.

Viscera.—The viscera are early affected by syphilis, and Dr. Coutts says that in 100 cases of inherited syphilis under his care the spleen was enlarged in 62, and in 19 others its size was probably above the normal. The splenic enlargement, he thinks, dates from birth, and may certainly exist before any other symptom of inherited syphilis has manifested itself. It is due to a simple multiplication of the normal cellular elements, and not to the formation of gummatous tissue. The liver is also affected in many syphilitic babies, the changes being those of an interstitial hepatitis. The jaundice is not usually a marked feature of the condition.

The mucous membranes are not markedly or early affected in the subjects of hereditary syphilis, though specific ulcers and mucous tubercles are found in the mouth and about the anus.

The Eye.—Iritis occurs in an early stage of inherited syphilis, and it is very likely to be overlooked, partly because it is rare, and partly because it does not cause any very acute symptoms. It usually appears within the first six months of life, is plastic in type, and occurs in both eyes. Adhesions are often formed between the iris and the capsule of the lens, but there is neither keratitis nor choroiditis in the earlier stages. The inflammation responds readily enough to ordinary antisyphilitic treatment.

Choroiditis occurs in the eyes of very young children, the subjects of inherited syphilis, often in association with manifestations of cerebral syphilis. The ophthalmoscope shows small flecks of exudation of a brownish colour, and apparently situated in the choroid; there is often but little disturbance of pigment, and no atrophy either of the choroid itself or of the optic disc, and the vessels of the fundus are altered in outline as a result of endarteritis. The condition may therefore be distinguished from the tuberculous choroiditis in which there are large, round, well-defined, and milk-white spots to be seen in the choroid,—a distinction which is of very great importance from a diagnostic point of view, and consequently for treatment.

The Nervous System.—The brain and spinal cord with their meninges are subject to the same syphilitic changes in infants as in adults. A chronic inflammation of the membranes of the brain may occur even during intra-uterine life, and may lead to a thickening of the dura mater. The chronic meningitis may or may not be associated with hydrocephalus; the child often has convulsions, and may be an idiot. It is sometimes correlated with inflammation of the cerebral substance which may become sclerosed and even calcified.

The cerebral arteries in syphilitic infants are subject to the same arterial changes as in adults with acquired syphilis. The endarteritis causes thrombosis, and may lead to hemiplegia, softening of the brain, and idiocy.

LATER SYMPTOMS.—Few diseases clear up so rapidly and satisfactorily as hereditary syphilis in young children, but few relapse so completely when the treatment is discontinued, and even in some cases in spite of treatment. Recurrence takes place as a rule during the second year, perhaps because the difficulties of teething have weakened the child, but it may be delayed for a longer period, and even until the changes at puberty reawaken any latent taint which may have existed.

The earliest symptoms of recurrence are usually associated with the mucous membranes. Sores may be developed at the angles of the mouth, and mucous tubercles may appear wherever there is a combination of moisture, warmth, and friction. True condylomata are sometimes formed, but they are much commoner in children who have acquired syphilis than in those who are the subjects of the inherited disease.

The bones suffer equally with the mucous membranes. Round and semi-fluctuating swellings are developed on the skull, especially upon the frontal bones, as well as upon the tibiæ and phalanges. The swellings are due to a gummatous periostitis, and usually disappear under appropriate treatment, but necrosis of the underlying bone may take place if they suppurate. A similar inflammation of the palate produces widespread destruction within the mouth, whilst the mucous membrane of the nose is liable to undergo extensive inflammatory changes which may involve the bones and cartilages leading to the depression of the bridge, which is thought by many to be one of the characteristic features of early syphilis.

Gummata are occasionally seen in the *skin*, but they are less common than in the children who have acquired syphilis, and they are much less easily cured by mercury.

The testes, and perhaps the ovaries, are affected by diffuse inflammation in some cases of hereditary syphilis. The body of the testis is generally affected, but the epididymis does not always escape. There is often a loss of, or diminution in, the sexual characteristics in persons who have been the subjects of hereditary syphilis, and it is thought that this alteration may perhaps be due to the changes occurring early in life in connection with the ovaries and testes.

Ear.—Deafness is an important complication of hereditary syphilis. It may begin suddenly at any age from infancy to adolescence, sometimes without warning, and with continuous subjective noises, due apparently to pathological changes in the labyrinth. Unhappily very little can be done to cure this form of deafness, which may lead to deaf-mutism when it occurs before the child has learnt to talk.

The latest signs of hereditary syphilis appear in the eyes, teeth, joints, and nervous system.

The Eyes.—Inflammation of the cornea is one of the best recognised amongst the later manifestations of hereditary syphilis. It is an interstitial keratitis which may begin at any age between five years old and five-

and-twenty, though it is most common about puberty. It may occur in those who are apparently in good health, and who have long been free from any sign of inherited taint. One eye first becomes irritable, and the cornea hazy, and after a time the other eye becomes affected in a similar manner. The corneal patches increase in size until the cornea becomes opaque like ground glass, and the patient is blind for all practical purposes, though he never loses perception of light. The inflammation is attended by a circum-corneal zone, due to congestion of the ciliary region, but there is very little conjunctivitis. The pain may be slight or severe. Sooner or later the corneal opacity becomes salmon-pink in parts due to the ingrowth of minute blood-vessels, and from that day the opacity begins to disappear, though the process is very slow, and the entire attack may take a year before it completely passes off.

The prognosis is good, and the patient can be buoyed up with the hope that he will almost certainly recover the greater part of his former vision, even when both eyes are affected severely, and he is nearly blind.

Retinitis.—Later in life, *i.e.* about the age of twenty-one, patients, and men more often than women, may present evidence of retinitis. Ophthalmoscopic examination shows the retina to be dotted yellowish-white, the veins are enlarged, and pigmented spots are seen chiefly in the equatorial region. There are central or annular scotomata. The colour sense remains normal as long as the disc shows no sign of atrophy. The retina is occasionally detached.

The permanent teeth show remarkable changes in the subjects of hereditary syphilis, especially in those who have interstitial keratitis. The changes are thus described by Mr. Jno. Hutchinson, who first drew attention to them:—

> "At or after the age of puberty the recognition of the subject of inherited syphilis may sometimes be made with great certainty; at other times it is surrounded by difficulties. Our most valuable aids are the evidences of past disease, more especially of inflammations which may have occurred in infancy. A sunken bridge of the nose caused by long-continued swelling of the nasal mucous membrane when the bones were soft, a skin marked by little pits and linear scars, especially near the angles of the mouth, the relics of an ulcerating eruption, and protuberant frontal eminences consequent upon infantile periostitis, are amongst the points which go to make up what we recognise as an heredito-syphilitic physiognomy. Added to them we have very valuable aid furnished by the shape of the incisor teeth. In these patients it is very common to find all the incisor teeth dwarfed and malformed. Sometimes the canines are affected also. These teeth are often narrow, rounded, and peg-like; their edges are jagged and notched. Owing to their smallness the sides do not touch, and interspaces are left. It is, however, the upper incisors which are the most trustworthy for purposes of diagnosis. When the other teeth are affected these very rarely escape; very often they are malformed when all the others are of fairly good shape. The characteristic malformation of the upper central incisors consists in a dwarfing of the tooth, which is usually both narrow and short, and in the atrophy of its middle lobe. This atrophy leaves a single broad notch (vertical) in the edge of the tooth; and sometimes from this notch a shallow furrow passes upwards on both anterior and posterior surfaces nearly to the gum. This notching is usually symmetrical. It may vary much in degree in different cases; sometimes the teeth diverge, and at others they slant towards each other. . . . In a considerable number of cases of heredito-syphilis the teeth show no deviation whatever from the normal standard . . . and it is only in the permanent set that any peculiarities are observed. The first set are liable to premature decay, but are not malformed."

The joints are affected about the same time as the cornea, and *mutatis mutandis* they appear to undergo similar pathological changes. The knees and shoulders are most often affected. A slight synovitis involves the joint on one side, and after a time the opposite joint begins to swell. Both joints remain inflamed for a long time, and the joint first affected recovers before the other. There is no permanent impairment of function as a result of the synovial inflammation.

The worst form of syphilitic arthritis is fortunately the most rare, for it does not respond to antisyphilitic remedies and is practically incurable. It occurs about puberty when a rarefying osteitis affects many bones and joints, and is associated with a deposit of caseating material in the cancellous tissue. A similar process taking place in the articular cartilages leads to the formation of irregular pits and grooves, and has led to the disease being described under the name of chondro-arthritis. The inflammation is marked by transient attacks of synovitis with evidence of chronic inflammation of the bones affected. There are often other signs of syphilis with evidence of long-standing iritis and choroiditis, and enlargement of the spleen.

The Nervous System.—There is an increasing tendency to believe that certain rare cases of tabes and general paralysis occurring about the age of puberty are parasyphilitic (p. 35) affections, even if they are not more directly connected with hereditary syphilis. Dr. Fletcher Beach says that in juvenile general paralysis there are, as a rule, no grandiose symptoms, but a steady progress towards dementia, and that the course of the disease is more prolonged than in adult cases.

ACQUIRED SYPHILLIS IN CHILDREN.—Syphilis may readily be acquired even by the youngest children and in a variety of ways. Local outbreaks have occurred from time to time as a consequence of arm to arm vaccination, and in the course of ritual circumcision, and although the methods leading to these sources of infection have been abandoned, many other means still remain. The lesions of acquired syphilis transmit the disease with much greater ease than those of the hereditary form, and it is important, therefore, to distinguish the one from the other. Acquired syphilis presents all the characters in children which mark the disease in adults, with certain modifications due to the tender age of the patient. There is a primary sore followed by a rash, which is fugitive, and differs from that of the hereditary syphilis in being roseolous. Snuffles and visceral affections are rare, but condylomata and gummata of the skin are common. The later skin eruptions, especially in scrofulous subjects, present a lupoid character, and the following case of gummatous synovitis shows how easy it would be to mistake such a joint disease for the more common tuberculous form :—

A boy aged 14 came under my care on the last day of January, with an inflammation of the right knee. He had diphtheria in September, and about a month afterwards sores appeared upon his body. He was noticed to be walking lamely about the end of December. The patient's complexion was muddy, and scattered over his limbs and scalp were patches of superficial ulceration covered with thick scales or with black and raised crusts. The voice was husky, but his teeth were healthy, and there was no evidence of keratitis or iritis, either recent or remote. The glandulæ concatenatæ, at the posterior border of the sterno-mastoid muscle, were slightly enlarged on both sides. The right knee was affected with synovitis, and there was some increase of synovial fluid in the left knee. The synovial membrane in both joints seemed to be thickened, especially at the sides. The patient occasionally felt a little throbbing pain, but unless the knee was moved it had never been severe, and he had not been awakened by starting pains at night.

The boy was brought by his mother, who said that his younger brother had had one ankle-joint excised for a similar condition, which had presumably been mistaken for a tuberculous arthritis, but she presented such obvious signs of tertiary syphilis that the patient was at once ordered one-grain doses of grey powder to be taken three times a day. In ten days' time his complexion had cleared, and he was less husky. There was also a smaller quantity of fluid in his right knee, whilst the left one was normal. The improvement continued until 7th March, when the patient was allowed to go about with his right knee in a plaster of Paris case. He returned on 26th March without the case, and complaining of much pain with increased swelling in both knees. Both joints were fixed with plaster of Paris bandages, but he again returned on 2nd April with increased swelling of both knees and some synovitis of both elbows. He then confessed that he had not taken his powders for a fortnight. The boy was made to understand that medicine was necessary to his cure, and he was ordered to continue the one-grain doses of grey powder three times a day. His elbows were less swollen and painful on 9th April, though his knees still remained enlarged. He was therefore given half-drachm doses of the solution of perchloride of mercury with five grains of iodide of potassium three times a day. A week later he returned, saying that his elbows were well, his knees better, and that he had suffered no pain since he began the new medicine. He increased in weight from 64½ lbs. on 16th April to 71½ lbs. on 30th April, and he has since remained well and at work.

TREATMENT.—The treatment of hereditary syphilis during the first year of life is easily summed up. It consists in judicious feeding and the administration of mercury, preferably in the form of grey powder or by inunction (p. 18). Cod-liver oil should also be given in the majority of cases. The mother should at all times suckle her own child when it is possible, and there is the additional reason in the case of hereditary syphilis that the child is born weakened, and with its digestive and assimilating organs in an unhealthy condition. But if such a child has to be bottle-fed, more than ordinary precautions must be taken to keep the bottle clean and the food sweet and free from fermentation.

Syphilitic infants react to mercury more rapidly and much more completely than adults, and they positively thrive on grey powder given in quarter or half-grain doses three times a day. If the grey powder causes diarrhœa or digestive disturbance a piece of blue ointment about the size of a pea may be rubbed into each groin every night, or the ointment may be spread on a piece of lint which is placed over the abdomen, and is kept in place by the child's binder. From twenty to forty grains of perchloride of mercury may be dissolved in the little patient's bath with excellent effects, especially when it is suffering from a rash. The mercurial course should be continued for at least six weeks after the last signs have disappeared, and by this means slight cases can often be cured completely within the first eighteen months after birth.

The later manifestations of syphilis, whether hereditary or acquired, are best treated with a combination of mercury and the iodides, and the treatment should follow the general lines recommended for adults.

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Syringomyelia.

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Definition.—The term syringomyelia is applied to a chronic progressive affection of the spinal cord, which is characterised by the presence of cavities and by proliferation of the glial tissue in the neighbourhood of the central canal. The origin of the disease finds its almost certain explanation in some anomaly of development, although it seems probable that additional factors are necessary for its production. The most striking clinical features of the disease are:—(1) A peculiar disorder of sensation, in which there is loss or diminution of the perception of painful and thermal sensations, with little or no impairment of the tactile sense; (2) various vasomotor and trophic disturbances in the bones, joints, and skin; and (3) progressive muscular wasting most frequently affecting the upper extremities. Not unfrequently there is some degree of spastic paraplegia; scoliosis and kyphosis are often present; bulbar symptoms are not uncommon and may be unilateral; diminution in the size of the pupil and narrowing of the palpebral fissure on one or both sides are frequently met with; the deep reflexes are almost always altered; disturbance of the functions of the bladder and rectum seldom occurs, excepting in the later stages of the disease.

Historical.—Ollivier (1827) introduced the expression syringomyelia (σῦριγξ = pipe, tube) to denote all canals or cavities in the spinal cord. The presence of cavities in the cord had, however, been noted from time to time for many years previous to this. The occurrence of symptoms, muscular atrophy, etc., in cases presenting the anatomical condition of syringomyelia was first drawn attention to by several observers in the middle of last century. Kahler and Schulze, working independently, pointed out in 1882 that it was possible from the character of these symptoms to diagnose syringomyelia during life. In consequence of this discovery great attention has been paid to the disease, and contributions to its literature have been very numerous. Of these, the monographs of Blocq (1890), Hoffmann (1893), and Schlesinger (1894) are probably the most important. A second and greatly enlarged edition of the latter work has recently appeared (1902).

Frequency of the Disease.—In this country syringomyelia is a rare disease. On the Continent it appears to be much more common. Schlesinger has personally observed 120 cases, and has had more than 30 post-mortems. This author makes the following remarkable statement (*Syringomyelie*, 1902, s. 266):—"In my opinion syringomyelia, or central gliosis, is one of the most common of the spinal cord diseases, and ought, as regards frequency, to follow closely tabes and the syphilitic and pressure paraplegias." A few lines lower down he adds that the disease is more often met with than multiple sclerosis, a statement which does not hold good in this country.[1]

Pathological Anatomy.—A reference to some facts connected with the development of the spinal cord will aid the elucidation of this subject.

At a certain stage of fœtal development the central canal of the spinal cord exists as a fissure-like cavity between the posterior columns. At a later date the posterior columns coalesce anteriorly, forming by their union the posterior commissure which separates the *true* central canal from the rest of the cavity lying posterior to it. As development proceeds, the latter cavity is gradually obliterated by a fusion of the posterior columns from behind forwards. But an arrest of development may take place before this obliteration is complete, in which case the cavity persists into adult life. Should development have been arrested before the formation of the posterior commissure, this cavity will be seen to include what would ultimately have become the true central canal.

The neuroglia of the adult spinal cord originates from embryonic cells which surround the central canal of the fœtus, and which in post-natal life lose their propagating qualities. Where development has been arrested, the embryonic cells which surround the fœtal central canal do not disappear, but are to be found as a thick sheath surrounding a dilated canal produced in the manner already described. This is the condition which we term hydromyelia, a pathological state unaccompanied by symptoms.

Under certain circumstances the persistent embryonal tissue above referred to possesses the property of proliferation. By its proliferation a *new formation* is produced which may cause considerable local enlargement of the cord. We apply the term syringomyelia to this condition, *i.e.* the occurrence of cavities in the cord associated with a *new formation* derived from the embryonic glial cells.[2] Syringomyelia is a further stage of hydromyelia; it is a progressive as opposed to a stationary condition. Whether a hydromyelia is capable at any time of taking on active growth and becoming a syringomyelia, we cannot say.

The spinal cord in cases of syringomyelia usually presents very obvious pathological changes to the naked eye. The membranes generally appear healthy, but there is sometimes considerable thickening of the dura, especially in the cervical region. Where there is extensive cavity formation, which is often the case, especially in its upper part, the cord is flattened from before backwards and feels soft and fluctuating. In places it may be greatly reduced in calibre, and may be no larger than that of a young child, while in regions where there is true tumour growth it may be considerably increased in size. Similarly, the medulla is sometimes much flattened. It, too, may appear smaller than normal. The diminution in size is often more pronounced in one-half of the organ than in the other. The aqueduct of Sylvius is sometimes greatly dilated. A condition of internal hydrocephalus, with thinning of the surrounding brain substance and flattening of the convolutions, is occasionally present.

The spinal cord on transverse section may present very different appearances according to the level at which the section is made. The presence of one or more cavities in the substance of the cord is often the most striking feature. It is most usual to find one cavity, more or less centrally situated, and lying posterior to the central canal, with which it is sometimes seen to be in direct communication. The cavity may be so large as to occupy the greater part of the transverse section, in which case it is surrounded merely by a thin tube of tissue; it may, on the other hand, be so small, that it is only recognisable with difficulty by the unaided eye. All gradations exist between these extremes. In some cases the cavity extends out through the whole length of the cord, from the filum terminale into the medulla; in others it is much more limited in extent; not uncommonly it is confined to the lower cervical and upper dorsal regions of the cord.

The wall of the cavity is usually smooth, and is composed of a layer of translucent embryonal glial tissue. It varies greatly in thickness, and its inner surface is covered by epithelium. The contents of the cavity vary; sometimes they consist of a clear fluid; in other cases the fluid is turbid, and it may have a brownish colour from recent hæmorrhages.

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[1] During the years 1896-97-98 there were admitted to the National Hospital, Queen Square, W.C., 2568 cases of "nervous disease," of which 159 were diagnosed as disseminated sclerosis, 11 as syringomyelia (cf. Registrar's Annual Reports).

[2] Some authorities hold that this new formation is produced by proliferation of the normal adult glial tissue, which is especially plentiful in the neighbourhood of the central canal.

The embryonal glial tissue, which has been above referred to in describing the wall of the cavity, consists of a network of neuroglial spindle cells and fine fibres in varying proportions. It may extend through the whole length of the cord. Its transverse extent varies at different levels. In some sections it is seen to surround a central cavity. It sometimes forms distinct tumours, causing considerable enlargement of the cord, and surrounded merely by a narrow ring of cord tissue. Cavities are often to be seen in the substance of this new formation; they have been produced by a breaking down of the tumour tissue. From what has been said regarding the development of the central canal, these various appearances will be readily understood.

In some cases an increase of the blood-vessels of the cord has been described; thickening of the vessel walls has been noted in a few instances. Ascending and descending degenerations are often to be seen in the white matter of the spinal cord. Degenerative changes in the peripheral nerves have been described by Hoffmann and others.

Etiology.—Syringomyelia is essentially a disease which owes its origin primarily to a developmental defect, and it is of interest to note that developmental defects of other parts of the body are not uncommon in individuals suffering from this affection.

Syringomyelia sometimes occur in association with spina bifida.

The disease is almost twice as common in males as in females.

The first symptoms most frequently appear during the second, third, or fourth decade, and especially between the ages of twenty and thirty.

Trauma appears to be a definitely related etiological factor in some cases.

Occasionally the symptoms of the disease have first attracted attention during convalescence from one of the exanthemata; several cases, for example, appear to have developed during recovery from typhoid fever.

Syphilis is believed by some authorities to play a part in determining the morbid process, but its influence in this respect is certainly not great.

The comparative rarity of syringomyelia in this country is of interest from an etiological point of view.

Symptoms.—The symptoms of syringomyelia depend upon the damage done to the spinal cord by the growth of the new formation, and to some extent possibly by the pressure produced by the distension of the cavity or cavities. Their incidence is determined by the part of the cord which is involved, and since this is usually the lower cervical or upper dorsal region, they are commonly referable to the upper limbs and thorax. Persistence of the central glial tissue and cavity formation may be unassociated with symptoms: it is only when the glial tissue takes on active growth that they become evident.

Dissociated anæsthesia, loss or diminution of the sensibility of the skin to thermal and painful impressions with preservation of the tactile sense, constitutes a most characteristic symptom of the disease. The explanation which is advanced to account for this dissociation assumes that the fibres which carry painful and thermal impressions are more centrally situated (they probably cross in the posterior commissure) after entering the cord than those which conduct tactile impressions, and are therefore involved at an earlier date by a lesion which extends from the centre of the cord towards its periphery.

The areas of cutaneous anæsthesia to painful and thermal impressions are not always co-extensive; the latter may be lost over a greater area and to a greater degree than the former. Similarly, the limits of anæsthesia for heat and cold do not always exactly correspond.[1] Very often a careful examination of the skin where there is thermal and painful analgesia will demonstrate a slight degree of tactile anæsthesia. In other regions the tactile anæsthesia may be complete.

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[1] Very occasionally there is anæsthesia to cold, heat being well felt. The reverse condition is sometimes met with. A few cases have been described in which the temperature sense has been alone impaired, there being no defect in the perception of pain.

The dissociated anæsthesia usually makes its appearance in the upper extremities or thorax. The head and face are not uncommonly involved; the lower limbs are rarely affected until the disease is far advanced. The anæsthesia is rarely symmetrical; it is almost always more extensive on one side than the other. When the face is anæsthetic a central mask, which includes the eyes, nose, and mouth, very commonly escapes. The anæsthesia is usually sharply limited. The frequency with which dissociated anæsthesia occurs as the first manifestation of the disease and its greater extent as compared with other symptoms, *e.g.* muscular atrophy, is accounted for by the central position occupied by the fibres, which conduct painful and thermal impressions.

Subjective sensations, such as pain in the back, feelings of heat and cold or of formication, etc., in the extremities, are not uncommonly complained of. Shooting pains in the arms and neck constitute a troublesome symptom in some cases.

The muscular sense, sense of position, and stereognostic sense are not usually affected to any great extent.

Muscular atrophy is one of the most important symptoms of syringomyelia, occurring in at least 50 per cent of the cases. The wasting has a distribution very similar to progressive muscular atrophy, commencing usually in the small muscles of the hand and causing flattening of the thenar and hypothenar eminences with sinking in of the interosseal spaces. The forearm may also be affected, especially the muscles on its ulnar aspect. The hand may assume a claw-like appearance, the so-called *main en griffe.* The muscles of the shoulder and upper arm are sometimes first affected as in the scapulo-humeral type of progressive muscular atrophy. The wasting is usually much more advanced on one side than the other. As the disease spreads the muscles of the trunk and neck become involved, and later the lower limbs may waste. Occasionally the atrophy is first seen in the muscles of the lower limbs; it may be that these cases are more common than is generally supposed, for they certainly often escape recognition.

Gradual loss of power accompanies the atrophy, and fibrillary tremors are seen in the affected muscles, while changes in their electrical excitability, such as are met with in progressive muscular atrophy, more especially a diminution in the Faradic response, occur.

Weakness in the legs, depending upon a certain degree of spastic paraplegia, is sometimes seen early in the disease, but is more common in the later stages. Increase of the knee-jerks and an extensor response may afford evidence of involvement of the pyramidal tracts long before there is any marked degree of weakness of the lower limbs.

A variety of *vasomotor and trophic* changes occur in the skin and its appendages. Thus the hands are often blue and cold; they may be swollen and œdematous. The skin in some places is thick and horny, sometimes it is thin and smooth. The nails are often cracked and furrowed; they may be much thickened. Bullæ, which vary in size, are often developed, especially on the upper extremities. They are filled with clear fluid which may become purulent. Sometimes they dry up and disappear, but they may leave an ulcerated surface which heals slowly.

Painless whitlows may develop on the fingers. The finger becomes swollen and œdematous, and suppurates. The swollen tissue necroses and the necrotic process may involve tendon, muscle, and even bone. These sores heal slowly and may leave considerable deformity. They are very apt to recur.

Changes in the joints are often met with, in 20 to 25 per cent according to Schlesinger. The trophic joint condition, which is known as Charcot's disease, is the same morbid process that is met with in tabes. It usually develops suddenly. The joint swells, and there may be considerable swelling of the limb in its neighbourhood. There is no pain, redness, or fever. Enlargement of all the tissues of the joint occurs, and often an extensive formation of new bone takes place in an irregular manner in this newly formed tissue. The ends of the bones in the neighbourhood of the joint may remain enlarged; commonly, however, atrophic changes take place, there is erosion of the cartilages, and wasting with, it may be, dislocation of the head of the bone.

The following table, which is taken from Schlesinger's work, illustrates the frequency with which the different joints are affected in tabes and syringomyelia:—

	Syringomyelia.	Tabes dorsalis (Büdinger).
Shoulder	52	38
Elbow	39	9
Wrist	22	?
Thumb	2	(finger joints) 8
Hip	6	59
Knee	10	110
Ankle	8	25
Jaw	4	2
Sterno-clavicular	6	?
Acromio-clavicular	1	?
Total	148 (150?)	251

It is interesting to note that whereas in tabes 80 per cent of the arthropathies occur in the lower extremities, in syringomyelia the relative frequency is almost exactly reversed.

In syringomyelia trophic *changes in the bones* sometimes occur, and spontaneous fractures, involving usually the bones of the upper limbs, are occasionally seen. The healing process in these spontaneous fractures is often very slow.

Scoliosis and kyphosis in the dorsal region of the spinal column are very frequently met with in syringomyelia, and although often of slight degree the deformity thus produced may be considerable. The spinal curvature may be in part due to weakness of the dorsal muscles, but trophic changes in the vertebræ are probably concerned in its production. Marie and Astié have drawn attention to a not uncommon deformity of the chest —the *thorax en bateau,* in which there is a sinking in of the anterior thoracic wall. Enlargement of the hands and feet similar to that seen in acromegaly is sometimes met with.

Bladder symptoms and disorder of the rectal sphincter seldom occur until the late stages, except in those rare cases in which the lumbo-sacral cord is first affected.

The sexual functions are very rarely interfered with.

In quite a number of cases there are signs of *paralysis of the cervical sympathetic* on one, often on both sides. There is a diminution in the size of the pupil on that side, with commonly some impairment of the light reflex, narrowing of the palpebral fissure, and retraction of the eyeball. The pupil fails to dilate with cocaine or when the eye is shaded. The sweat secretion is diminished on that side of the face and neck.

Bulbar symptoms are not uncommon and are often unilateral. Paralysis of one-half of the palate and tongue and of one vocal cord is a common association. Facial paralysis is sometimes seen. Alterations in articulation depending on these various paralyses may be present. Nystagmus is fairly frequent, and occasionally some of the external ocular muscles are paralysed.

Vision is not usually interfered with. The optic discs are almost always normal. The fields of vision rarely show pathological changes. In most of those cases where there has been peripheral contraction an hysterical element has been present.

The symptoms in syringomyelia vary according to the position of the lesion. Thus Schlesinger recognises *four types:* (*a*) cervical, (*b*) dorso-lumbar, (*c*) sacro-lumbar, and (*d*) bulbo-medullary.

Further, great differences occur in the clinical picture of the disease according to the preponderance of individual symptoms; thus in one case the muscular wasting, in another sensory changes, while in another trophic alterations, forms the most striking feature.

DIAGNOSIS.—There is no single symptom which is absolutely pathognomonic of syringomyelia.

The form of dissociated anæsthesia which occurs in this disease and constitutes its most constant and characteristic symptom, may be met with in hysteria and occasionally in a peripheral neuritis.

A pure dissociated anæsthesia of the syringomyelic type accompanied by a slowly progressing muscular atrophy can only depend upon a progressive intra-spinal lesion, syringomyelia, or other central new formation.

If in addition there are characteristic vasomotor and trophic changes, the diagnosis of central gliosis (syringomyelia) is practically assured. Further evidence is forthcoming if the distribution of the symptoms is such as to point to the cervico-dorsal region of the cord being the seat of disease, for it must be remembered that this is the region most commonly affected. Such symptoms are wasting of the hand muscles, anæsthesia of the upper limbs and thorax, sympathetic paralysis, spinal curvature, spastic paraplegia, etc.

Great differences occur both as regards the nature and the distribution of the symptoms. In one case muscular atrophy, in another sensory changes, or again trophic lesions, painless whitlows, cutaneous bullæ, etc., may constitute the most striking feature at the time the case comes under observation.

It must not be forgotten that, although the cervico-dorsal region of the cord is much the most common seat of the disease, cases occur in which the lower part of the cord is also, or it may be alone, affected. In such a case the sensory changes, muscular atrophy, etc. are located in the lower limbs. Cases of bulbar syringomyelia also occur. These atypical cases are probably often unrecognised. It is important to realise this, in other words, to dispel the misconception which appears to be very prevalent that syringomyelia is essentially a disease which manifests itself in the upper extremities. Bearing in mind that *the character of the symptoms is of greater diagnosic importance than their distribution,* in considering the differential diagnosis it will be convenient to refer especially to the cervico-dorsal or common type of the disease.

A number of different conditions may closely simulate syringomyelia, especially in its early stages. The classical case in which there is wasting of the hands is often diagnosed as *progressive muscular atrophy.* More than once I have seen this mistake occur. The explanation is that the latter disease is much more generally recognised, and its symptoms more widely known than those of syringomyelia. *In every supposed case of progressive muscular atrophy syringomyelia must be excluded before a positive diagnosis is arrived at.* The hands, arms, shoulders, and thorax must be most carefully examined for any trace of dissociated anæsthesia, the existence of a patch of which, often of very limited extent in early cases, will determine the diagnosis between the two diseases under consideration.

Trophic changes in the skin, whitlows, bullæ, etc., arthropathies, spinal curvature, and sympathetic paralysis will, if present, confirm the diagnosis of syringomyelia. Stigmata of degeneracy, such as defective formation of the pinna of the ear, extra digits, an abnormally high palatal arch, an asymmetrical head, etc., are signs to which one is inclined to attach some weight in diagnosis, for they occur in quite a considerable proportion of cases.

Amyotrophic lateral sclerosis is another disease for which syringomyelia may be mistaken. The points of differential importance are similar to those which we have considered under progressive muscular atrophy. In addition, spasticity of the upper limbs with increased arm-jerks, a markedly exaggerated jaw-jerk, an increase of the excitability of the muscles on mechanical stimulation, are usually present in this disease, and will serve to distinguish it from syringomyelia.

The diagnosis of syringomyelia from an *intramedullary spinal tumour* is always difficult and may be impossible, for these tumours not unfrequently arise from a pre-existing central gliosis.

Cervical pachymeningitis is commonly associated with wasting of the upper extremities and anæsthesia; it may, however, be usually distinguished by the severe shooting pains which are commonly present in the arms. Further, the anæsthesia is not of the characteristic syringomyelic type, while vasomotor and trophic changes and spinal curvature do not occur. It must be remembered that the two conditions—syringomyelia and pachymeningitis—are sometimes associated.

An *extra-medullary tumour* may also produce muscular wasting and anæsthesia, with paraplegia. If situated in the cervico-dorsal region pains in the arms are usually complained of. Severe pain in the back is a common symptom. Brown-Séquard's paralysis, if present, affords strong support to the probability of a tumour. Other symptoms of syringomyelia above referred to are commonly absent. Dissociated anæsthesia is sometimes produced by an extra-medullary tumour. In a case of extra-medullary tumour, which was under the care of Dr. Byrom Bramwell, this symptom was present. The tumour, which was of small size, pressed on the cord in the upper cervical region. The absence of pain in the back and of root pains in this case, and the presence of wasting of the upper limb, dissociated anæsthesia, etc., suggested syringomyelia, a diagnosis which was shown post-mortem to be erroneous.

The cervical region of the cord and cervical root may be pressed on in *spinal caries*, but in this case, if the symptoms have persisted for any length of time, signs of disease of the vertebræ (irregularity, rigidity, pain on movement, tenderness on pressure) usually co-exist.

Brachial plexus neuritis may simulate syringomyelia, but the signs of irritation (pain, etc.), the history, and the strictly unilateral distribution of the symptoms, usually permit of a diagnosis being made without difficulty.

Occasionally *disseminated sclerosis* is resembled by syringomyelia, but the absence of anæsthesia, the speech affection, giddiness, and frequency of optic atrophy in the former disease, together with the history, usually place the diagnosis beyond doubt.

Hysteria and syringomyelia have been confused, and—strange though it may seem—the possibility of such a difficulty arising is not remote when it is remembered that the two diseases are not uncommonly associated. Definite signs of organic disease, such as local muscular atrophy, etc., must be sought for in determining this question.

An *acute central myelitis* or *hæmorrhage* into the cord may produce symptoms identical with those of syringomyelia. The history of onset is in such a case the chief guide to the diagnosis. *The possibility of pre-existing syringomyelia should always suggest itself where the history appears to indicate spinal hæmorrhage.* Careful inquiry must be made as to the existence of symptoms suggesting syringomyelia prior to the acute onset. Rapid extension of the lesion through a considerable vertical extent of the spinal cord is suggestive of hæmorrhage into a pre-existing cavity.

MORVAN'S DISEASE.—No article on syringomyelia, however brief, would be complete without a reference to the symptom complex which is known as Morvan's disease.

Morvan, a French physician, described in 1883 a group of cases which he had met with in Brittany, the chief symptoms of which were extensive whitlows, analgesia of the upper extremities, atrophy of the arms and hands, pains in the arms, arthropathies, spontaneous fractures, etc.

At the first glance the resemblance of these symptoms to those of syringomyelia is striking. In the cases described by Morvan, however, the trophic lesions of the fingers occupied such a prominent place in the clinical picture that many authors, among them Charcot, held that Morvan's disease was a distinct condition; other observers were of opinion from the first that syringomyelia and Morvan's disease were identical, a view which received support from post-mortem evidence, for it was found that central gliosis and cavity formation was present in both groups of cases. In more than one case of Morvan's disease changes were found in the peripheral nerves, a fact which the supporters of the independent nature of the two diseases were not slow to grasp. Hoffmann, however, who paid particular attention to this question, showed that in some cases which answered to the clinical description of Morvan's disease there were no discoverable peripheral changes; while he found, on the contrary, that changes in the peripheral nerves were sometimes present in syringomyelia. According to Hoffmann, "Die maladie de Morvan unterscheidet sich also ebensowenig anatomisch von der Syringomyelie wie klinisch" (*zur Lehre von der Syringomyelie*, s. 58.) *The opinion that Morvan's disease is nothing more than a type of syringomyelia is almost universally held by neurologists at the present time.*

A possible etiological relationship between syringomyelia and *leprosy* was suggested by Zambaco in 1892. This author drew attention to the circumstance that in Brittany, where Morvan's disease was first recognised, leprosy was somewhat prevalent, and pointed out that some cases which had been classed with Morvan's disease were probably examples of the former affection. When it is remembered that in leprosy, muscular atrophy, various kinds of trophic lesions and even dissociated anæsthesia occur, the possible resemblance will be apparent.

That *the two diseases are quite distinct and depend upon a different pathology* appears to have been proved by Laehr, who has devoted much attention to the study of this question.

Laehr came to the conclusion, from the examination of a large number of cases of leprosy, that in every case of leprosy changes were present in the peripheral nerves, and that the pathological changes in the spinal cord which occur in leprosy, especially in the posterior roots and posterior columns, could only be regarded as secondary. Central gliosis and cavity formation are not found in leprosy. In a considerable proportion of cases of leprosy the bacillus of that disease is detected in the spinal canal and peripheral nerves, whereas, in no case presenting the undoubted characters of syringomyelia or Morvan's disease has it been found.

Prognosis.—Syringomyelia is an incurable disease. Its course varies greatly in different cases, and is, as a rule, very chronic. Although showing a tendency to slow progression, intermissions, with temporary slight improvement, are not uncommon. Occasionally the disease appears to be arrested for long periods of time. I have seen a case, for example, where for thirteen years the patient remained *in statu quo*, when the symptoms again began to progress. Patients with syringomyelia have been known to live thirty or forty years. Déjerine has even reported the case of a man in whom muscular atrophy commenced fifty years previously. The prognosis is less favourable where the lumbo-sacral region of the cord is involved and bladder symptoms are present, for in these cases there is always a risk of cystitis and subsequent general septic infection.

Schlesinger states that in bulbar syringomyelia the prognosis is much more favourable than in other subacute or chronic bulbar lesions; he mentions the case of a man who has had widespread bulbar symptoms for twelve years and who still goes about fairly well. Often the symptoms are exaggerated after an infective process, *e.g.*, influenza. Sudden apoplectiform attacks, which have been ascribed to hæmorrhages into the tumour tissue and to variations in the intraspinal pressure, may occur at any time and may prove fatal.

Cystitis, general septic infection from a whitlow or other local cause, extension of the process to the medulla, and intercurrent affections, such as phthisis, are the most common causes of death.

Treatment.—No treatment is known which influences the progress of the disease.

The patient should be advised to avoid over-exertion, more especially of those muscles in which there is commencing atrophy. He should be warned to take the greatest precautions to avoid local injury, for a slight abrasion of the skin may be the starting-point of a trophic sore. If pain is a troublesome feature various analgetics may be employed. Other symptoms are to be treated as they arise by appropriate remedies. Occasionally it may be considered advisable to excise a joint; favourable results have been obtained by this procedure. In a case under the care of Sir William Gowers I have seen Sir Victor Horsley open the spinal canal and drain the cavity. The result as regards improvement was not, however, encouraging. Schlesinger is opposed to spinal puncture on the ground that such a procedure may lead to spinal hæmorrhage.

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Tabes Dorsalis.

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SYN.—*Locomotor Ataxy;* Fr. *L'Ataxie locomotrice.*

DEFINITION.—A progressive degeneration of the nervous system, affecting especially the sensory structures, and characterised by atrophy of the posterior columns of the spinal cord.

HISTORICAL INTRODUCTION.—Our knowledge of tabes is the product of the last fifty years; before that period, except for a few isolated observations by W. Horn (1827), and von Steinthal (1844), these cases were all classed as paraplegia. In 1851 Romberg described the leading symptoms of the disease—optic atrophy, small fixed pupils, lancinating pains, girdle sensation, stamping gait and swaying of the body when the eyes were shut, which last-named symptom bears his name. The Germans naturally claim Romberg as the discoverer of the disease; the French, on the other hand, claim Duchenne as the discoverer of the disease, and have even gone so far as to name it after him; they might with greater justice claim the discovery for Cruveilhier, for he in 1845 described a case and noted the grey degeneration of the posterior columns of the spinal cord. Although it was ten years after Romberg that Duchenne gave his masterly description, to which there is not much to be added and very little to be taken away, yet it was the graphic description by this clinical genius, and especially his demonstration that the ataxy was due to a failure of the correlative antagonism of synergic groups of muscles, that the disease became universally recognised, and for a long time bore the name which Duchenne gave it of locomotor ataxy.

Sir William Gowers claims that Todd discovered the disease, not I think quite justly, although he, later than Cruveilhier, made the independent observation of sclerosis of the posterior columns.

The term tabes is more applicable to this disease than locomotor ataxy, for the latter is one symptom and may not be a prominent feature, or even present during the whole course of the disease. Since Duchenne's description of the disease, an enormous number of clinical observations by different observers have been made, showing the polymorphic character of the affection.

ETIOLOGY.—It is becoming more and more an accepted fact that, of all the causes of tabes, syphilis is by far the most important; in fact it is the opinion of many authorities that if there were no syphilis, there would be no tabes; and Fournier, who first pointed out the frequency of syphilitic infection in tabetic cases, calls it a para-syphilitic affection, and Möbius meta-syphilis. Another disease with which tabes is intimately associated, and so closely allied as to be thought by many authorities to be one and the same disease, affecting different parts of the nervous system, is general paralysis. The pathogenesis of the two diseases is almost identical, and I have found all grades of the disease, from tabes without mental symptoms, tabes with slight mental symptoms, and tabes with severe mental symptoms, to pronounced general paralysis. According to my observations, by far the most important, if not the essential factor is syphilis. The work of Erb has probably done more than anything else to support the doctrine of Fournier. In 1897 he had collected 900 cases of tabes, of which 90 per cent had suffered with syphilis; he found in 6000 other nervous cases on the same basis of evidence only 20 per cent. Westphal, Charcot, and Virchow were always opponents of the syphilitic doctrine, but the greatest opponent has been Leyden; various authors have given different results, and very much depends upon what each considers sufficient evidence to warrant the assumption of syphilitic antecedents. Max Norme points out that as the interest in the subject has increased, the authorities who had previously only found a small percentage of tabetic patients suffering with syphilis, were led, as the inquiry progressed, to increase their percentages.

It is argued that in countries where syphilis is prevalent tabes may be very rare, as in Bosnia and Herzgovina. Another factor is undoubtedly necessary for the production of this disease, as well as for general paralysis, and that is nervous instability, the product of civilisation; and Kraft-Ebbing sums up the causes of general paralysis as civilisation and syphilisation.

Sex.—The facts with regard to sex, age, and incidence of the disease all support the syphilitic doctrine—males are much more frequently affected than females, tabes is uncommon in women of the better classes, and when it occurs there is usually history of syphilitic infection. The disease commences in adult life, generally in the fourth or fifth decade, and about ten to fifteen years, I have found, after the primary infection; although the interval may vary from four to twenty-five years. When it affects juveniles it is invariably in the subjects of congenital syphilis.

Heredity.—Charcot laid great stress upon the neuropathic temperament as a cause of the disease; there can be little doubt that it is the quick-brained, active, and sexually excitable individual who is more prone to the disease; but one does not find a large percentage of cases giving a hereditary neuropathic taint.

Stress.—Edinger has pointed out the importance of stress as a determining factor in the production of tabes; most of my cases certainly were engaged in occupations which involved physical stress, and several of those in which the symptoms began in the arms were individuals who used their arms in their respective occupations. Thus among my own cases of cervical tabes, in a mounted policeman, it began in the arm with which he held the reins; it began in the arms in a parcel-post sorter and in two packing-case makers. Edinger has demonstrated the fact that degeneration of the posterior columns can be induced in animals by excessive stress on the limbs, especially in conjunction with an artificially produced toxæmic condition. The importance of stress as a factor has also been emphasised by Byrom Bramwell.

Exposure to Cold and Wet and unequal Temperature.—The frequency with which, in my experience, engine-drivers, policemen, postmen, workers at forges, and others subject to such conditions are liable to the disease supports this view, together with the fact that it has been noticed that tabes has come on after the stress and hardships of a campaign in military men. Leyden and Goldscheider lay great stress upon exposure to cold, wet, and unequal temperature, but most authorities consider it as only a contributory factor.

Sexual excesses were formerly considered to be the cause — the essential cause—of tabes, but the undoubted satyriasis which occurs in many cases is not the cause but the result of the increased irritability, prior to death, of the nervous structures of the spinal cord, subserving the function of the sexual instinct. Still, one cannot get away from the fact that people who suffer with tabes dorsalis are those especially who have lived a fast life and indulged *in Baccho et in Venere.*

Alcohol.—It is improbable that alcohol of itself without syphilis can, when taken in excess, produce tabes. It can, however, produce neuritis, consequently is a potent agent in the production of irritation and destruction of nervous tissue, and may, therefore, act as an important contributory factor in the production and the rapidity of progress of the disease.

Trauma.—Klemperer collected a number of cases in which there was a history of injury preceding the onset of the disease. A classical monograph by Hitzig dispossessed Klemperer's observations of much of their import; and it may be accepted that there are but few cases in which true tabes, apart from syphilitic and other factors, exists. To sum up the etiology, it is the opinion of the author that syphilis, if not the one essential factor, is proved to be by far the most important factor, but that it operates only when in conjunction with several contributory predisposing or determining factors, namely, stress (physical and mental), exposure to cold and wet, alcoholism, sexual excesses, insufficient sleep, and occasionally trauma; also the psychopathic, neuropathic, or neurotic temperament, the conditions which, without syphilis, would determine neurasthenia. The same factors are contributory to the production of general paralysis, but more frequently in the latter than in tabes there is a hereditary history of insanity.

SYMPTOMATOLOGY.—Tabes is a polymorphic degeneration; although there are certain cardinal symptoms, one or more of which, in conjunction with some other or others, is necessary before a diagnosis can be made. Still no two cases present exactly the same clinical features, although there is by the presence of one or more of these cardinal symptoms a universal similarity. They are as follows:—The Argyll-Robertson pupil; absent knee-jerks; lightning pains; visceral disturbances, especially bladder troubles; disturbances of sensibility.

The most important symptom undoubtedly is the Argyll-Robertson pupil, for in no other disease except general paralysis does this sign exist, and, as pointed out by Sir William Gowers, in some cases of syphilis it may be the sole objective evidence. In fact, the existence of the phenomenon alone would justify one in saying that the patient was a candidate for either tabes or general paralysis. This is the strongest argument in favour of the unity of these two diseases and of their syphilitic origin.

Eye Symptoms.—We will consider first affections of the optic nerve. One of the earliest subjective symptoms which will bring a patient under the doctor's observation is failure of sight; thus, a large number of cases in the preataxic stage are seen by the oculist. The patient may complain of dimness of vision, "things look as if smoky," or "as if a veil were in front of the eyes"; one eye is usually affected much more than the other, and it may be that not until he has lost the sight of one eye, which may happen, apparently quite suddenly, owing to the destruction of the macular fibres, does the patient seek advice. Examination of the fundus shows the disc with a sharp-edge dead-white appearance, or greyish-white, with often the lamina cribrosa shining through, giving it a mother-of-pearl appearance, the vessels normal in size and appearance, and in advanced cases, sinuous on account of the cupping of the disc. Sometimes there is amblyopia without opthalmoscopic changes. The optic atrophy will cause failure in colour vision, and if tested perimetrically there may be a marked limitation of the field of vision; and colour-blindness may occur, red and green disappearing usually before blue and yellow. Patients suffering with optic atrophy frequently remain for long periods of time in the preataxic stage; in fact, may never show ataxy at all.

One of my patients was twenty years in that stage. It is usual for neurologists to give comfort to their patients by telling them that although they are blind, they will probably remain free from locomotor troubles for a long time to come.

There is another side of the picture which is seen especially by the alienist, and it is my experience that a large number of these cases become tabo-paralytics.

From the observations made on sixty cases of tabo-paralysis with thirty post-mortem examinations, including microscopical examinations, I have been struck with the large number (40 per cent) that have suffered with optic atrophy, and in many instances complete blindness.

Ocular Paralysis.—Another cause of the patients seeking advice at an eye hospital is double vision; they do not go there because of the squint, as a rule, but because the vision of two objects attracts their attention and interferes with their occupation. The ocular paralysis may be paralysis of a single muscle, that of the external rectus on one side, being the most frequent. Ptosis on one or both sides, paralysis of the internal rectus or even complete paralysis of the third nerve, but much more frequently it is a partial paralysis affecting one muscle. The early ocular paralyses are usually transient, lasting a week or two or a month or two, and then disappearing; they may, however, be permanent.

There may sometimes be opthalmoplegia externa affecting one, but more often both eyes, in which all the external muscles of the eyeball are paralysed. This is a permanent paralysis.

Pupil Phenomena.—The attention of the physician may be attracted by the small, even pin-point pupils, or by unequal pupils; or while the patient is suffering severe pains or crises, he may notice that the pupils do not dilate. By far the most important symptom, however, and one which, if present, renders a diagnosis certain, is the Argyll-Robertson pupil, *i.e.* the pupil reacts to accommodation, but not to light or painful stimulus. This phenomenon is usually present in both eyes, but it may be present in one and not in the other; the reaction to light may be sluggish as compared to accommodation, but it must be remembered that sluggish reaction to light is not necessarily a pathological condition, and unless there is a difference between it and accommodation, it may be of no import. In my cases 73·5 per cent showed Argyll-Robertson pupils on both sides; 3 per cent showed Argyll-Robertson pupils on one side; 3·7 per cent were sluggish to light; and 15 per cent were inactive to light and to accommodation.

Irregularity of the pupils is also very frequent, and independently of *synechiæ,* the pupil may be angular, elliptical, or oval.

Sensory Symptoms. — *Subjective.* — The earliest and most constant symptom, and one for which the patient will often seek relief, are the lightning pains. He may consider them rheumatism or sciatica; or, even when occurring in the thorax, they may be mistaken for pleurisy or pleurodynia. They occur in paroxysms and shoot down the limbs, or may be localised in some particular part. They are deep-seated and are described as "boring, burning, stabbing, or shooting." They generally last during the whole course of the disease, and the skin may be hyperæsthetic during the attack; and in rare cases of a severe nature, paroxysms of pain may be followed by herpetic or erythematous, even bulbous eruptions. The patient may complain of formication, pins and needles, and numbness—a feeling like putty or wool on the soles of the feet. These subjective symptoms are spoken of as paræsthesia.

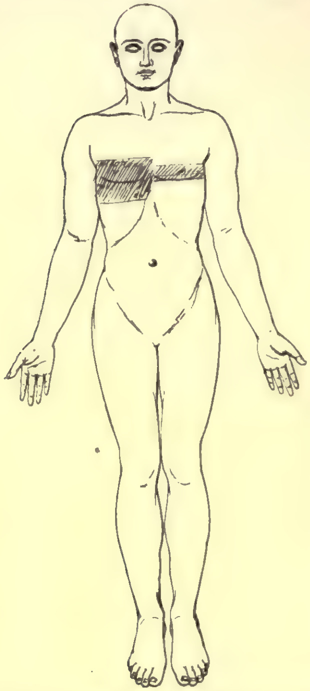

FIG. 1.—Sensory disturbances of a case of tabes in the preataxic stage. Cutaneous thoracic anæsthesia to light tactile impressions (just perceptible touching with the tip of the investigator's finger, the patient's eyes being covered). The sensory disturbance corresponds with the distribution of the fourth posterior root on the left side, and with the third, fourth, and fifth on the right. This patient presented no ataxic signs or symptoms, the knee-jerks were present on both sides. For more than a year the sole subjective symptoms were gastric crises. The diagnosis was made upon the presence of Argyll-Robertson pupils, and cutaneous thoracic anæsthesia, associated with attacks of vomiting and pain at the epigastrium. The anæsthesia extended as the disease progressed.

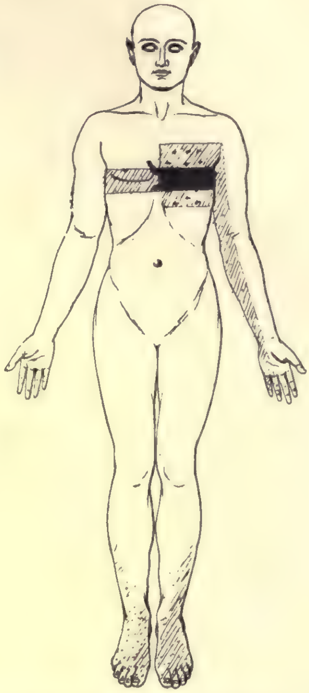

FIG. 2.—Sensory cutaneous disturbances of a case of tabes in the first stage of ataxy. The chart shows that on the left side the anæsthesia to light tactile impressions has spread down the inner side of the arm and hand (ulnar distribution) and would indicate that the posterior roots of the seventh and eighth cervical, and first to seventh dorsal were involved; whereas, on the right only the third, fourth, fifth, and sixth dorsal are affected. Owing to the overlapping of the sensory nerves to the skin corresponding to root segments, an area of cutaneous anæsthesia corresponding to two roots really means involvement of a root above and below. Above the second space the skin is supplied by the cervical plexus, consequently there is no anæsthesia. The black band indicates complete anæsthesia and analgesia. The crosses indicate some hyperæsthetic spots. There is also hypæsthesia and hypalgesia of the feet and peroneal side of legs. This indicates affection of the lumbo-sacral roots, third, fourth, and fifth lumbar, first and second sacral, and accords with the lightning pain in the legs, the bladder troubles, the absent knee-jerks, loss of joint sensation in toes, and ataxy.

Objective Symptoms.—Disturbances of cutaneous sensibility to light tactile impressions, to painful impressions, as by pricking, and to heat and cold are found. The researches of Lähr have shown that one of the earliest and most constant signs of tabes is cutaneous *trunk anæsthesia* to light tactile impressions, and this probably accounts for the frequency with which "a girdle sensation" is experienced. I found it present in forty out of forty-seven cases. The zone of anæsthesia usually affects the fourth and fifth segments, and extends as the disease progresses above and below. It is very rare that it extends to the second interspace, the reason being that the cervical plexus supplies the skin in this region, and it is seldom that the upper cervical roots are affected. The anæsthesia may extend down the ulnar side of the arm; there may be hyperæsthesia above and below the anæsthetic region; this cutaneous anæsthesia of the thorax demonstrates the segmental character of the degenerative process. The region next most liable to be affected is the part supplied by the lumbar sacral roots, so that the feet and legs, especially the peroneal side, often show, even early in the disease, disturbance of sensibility. Here it is, however, more frequently loss of, or diminished sensibility to, pain. Sensibility to heat and cold persist much longer, and it is only in very advanced cases that they are lost, and then very frequently cold produces a burning sensation. Anæsthesia and analgesia of a skin area may be preceded by hypæsthesia and hypalgesia. In testing sensibility it will often be noticed that there is great delay in the response to stimuli,[1] and that after repeated stimulation an area which was previously anæsthetic or analgesic becomes sensifacient by a process of summation. Wrong localisation of the parts stimulated is frequently observable, and occasionally there is a condition of *allochiria*, that is, referring sensation to the wrong side of the body (see Figs. 1, 2, 3).

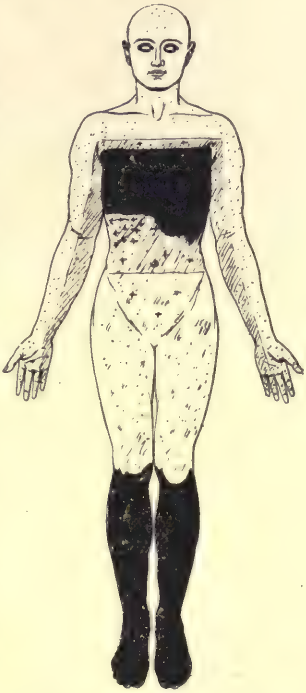

FIG. 3.—Sensory cutaneous disturbances of a case of tabes in an advanced stage of ataxy. The patient was unable to walk without support. Deep reflexes of upper and lower limbs lost, superficial reflexes absent except over right epigastric region, where there was such hyperæsthesia and pain as to simulate pleurisy. She suffered with very severe gastric crises for some years; now that there is complete analgesia and anæsthesia over the area of the thorax indicated black, this symptom has ceased. The chart indicates complete destruction of the lumbo-sacral roots, and also of all the dorsal roots except the lower four or five, which together with the upper one or two lumbar are only partially destroyed. The light shading indicates cutaneous anæsthesia, the dots hypalgesia, which is very extensive in its distribution, affecting the upper cervical roots and a portion of the distribution of the fifth.

Loss of cutaneous sensibility, and its extension over the surface of the trunk and limbs, progresses with the disease, but there may be pronounced ataxy without any loss of cutaneous sensibility. The bone sensibility may be lost; this can be ascertained by placing a vibrating tuning-fork on the tibia, when it will be found that the patient is unconscious of its presence. The ulnar symptom of Biernacki is another sensory test. Compressing the ulnar nerve at the elbow does not cause the well-known tingling in the fingers.

Superficial Reflexes.—These may be present and active in the early stages of the disease; the plantar reflexes are absent when there is loss of sensibility in the soles of the feet; and it is common to find these absent while the epigastric are present, even exaggerated. A hyperæsthetic skin area is usually associated with increased superficial reflexes. Very frequently after an attack of pains, during which the skin is hyperæsthetic, it is subsequently left anæsthetic, the explanation being that the root fibres which convey sensations from this skin area were in a process of increased excitability prior to death, and I have several times noticed a belt of anæsthesia follow a severe attack of pain associated with gastric crises.

Joint sensibility.—A very early symptom is the loss of sense of position of the joints, and in the great majority of my cases, where there was any recognisable ataxy in the legs, there was at the same time a loss of sense of position in the toe-joints. If the toe be bent with the patient's eyes shut, he is unconscious of its change of position; as the disease progresses and the incoördination becomes more marked, the other joints of the lower limb, ankle, knee, and hip, are successively affected. Likewise the finger joints, then the wrist and elbow, when the upper limb is affected.

Sense of Position of the Limbs.—With the eyes shut, the patient is unable to place the heel of one foot on the toes of the other: his knowledge of the position of his limbs is lost through the loss of the muscular sense impressions. Likewise he is unable to touch the tip of his nose, or to make his fingers meet.

Muscular Tonus.—Owing to the loss of the sensory impressions from the limbs the reflex spinal tonus is greatly lowered, and as a result of this loss of tonus the *deep reflexes*, the knee-jerk, the Achilles tendon-jerk, and the triceps-jerk are abolished. The absence of the knee-jerks is one of the cardinal symptoms of the disease, but it must be borne in mind that in other diseases the knee-jerks may be absent, and in not every case of tabes are the knee-jerks absent. In cases of arm tabes, in cases of tabo-paralysis, and in very early cases of tabes the knee-jerks may be present on one or on both sides. To elicit the knee-jerk one knee should be crossed over the other, or the foot may be placed on the ground with the leg at a right angle to the knee, or it may be supported on the arm of the operator in such a way that it hangs freely over. The tendon should be struck with a percussion hammer, and if the jerk be not elicited, the patient should be told to look at the ceiling and pull his clasped hands apart, when occasionally it will be found to be present, when previously not obtained. A condition of hypotonus is generally present, and proportional to the degree of ataxy. If the patient be made to lie on his back on a couch, the hypotonus of the ham-string muscles can be demonstrated in the following manner: the patient, lying flat on his back, is told to keep one leg extended on the couch, and the other is raised by the operator with the knee extended. It will be found that the leg which in a normal individual cannot be raised to an angle of more than 120° with the trunk, can, owing to the laxity of the ham-string muscles, be raised to a right angle, and in advanced cases even to an angle of 60° with the body.

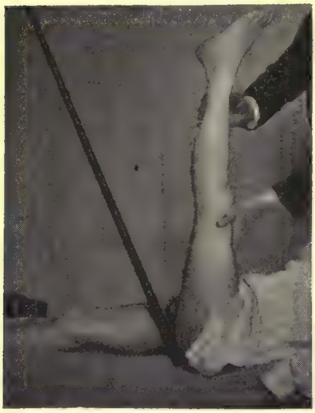

Fig. 4.—Muscular tonus.

Although there is this loss of tonus of the muscles and in advanced cases marked wasting, it will be found that all the muscles respond normally to Faradism and galvanism; yet the patient in the third stage is in a paralytic condition. He is paralysed because the sensory paths, essential for coördinate movement, are destroyed.

Disturbances of Gait and Station.—A patient may first notice that he has difficulty in walking in the dark, in going up and down stairs, or that on washing his face he has felt as if he would fall, or quite suddenly he has had a "giving way" of the legs; such conditions mark the first stage experienced by the patient of ataxy. He may be tested in the following way, for when he walks into the room in the daylight he may not show the characteristic disturbance of station and gait. *Romberg symptom* is the inability to stand without swaying when the eyes are shut; this is generally present. If it is not obvious it will perhaps be found that he cannot stand on one leg, and especially if he shuts his eyes. If he is made to raise himself on his toes with the feet close together and returning on his heels he will probably have a difficulty to retain his equilibrium. If asked to walk a chalk line he may thus show the disturbance, or if suddenly asked while walking to turn round he tends to lose his equilibrium. When observing the gait it may be noticed that he walks with rather a wider base than normal; as the disease becomes more pronounced the ataxic gait becomes more evident. He looks at his feet where he should place them; the gait is stamping, the heels being brought down first, the toes being pointed outwards and the knees extended. He throws out the advancing leg and does not bring into play the synergic muscles associated with flexion of the hip, namely the flexors of the knee and the dorsal flexors of the foot. As the disease becomes more advanced the incoördination becomes more manifest, and the patient constantly requires a stick or some one to assist him in walking. The gait is quite characteristic even to the layman. The shoulders are bent forward, the eyes looking to the feet, the knees hyperextended, the legs being thrown out in a sudden jerky manner, and the foot stamped heavily, heels first, on the ground. The steps are unequal, and he would fall if he were not supported, or if his attention were taken off the feet.

In the third stage of ataxy the patient is unable to stand. The anæsthesia may be so pronounced that lying in bed he is unconscious of the existence of his legs. Usually in this stage there is a great deal of muscular wasting and some deformity, such as talipes varus, equino varus or equinus.

It is very rare that the *muscular atrophy* is due to degeneration of the motor nerves. In some few cases ataxy begins in the arm before the legs. It affects the finer movements first, such as writing, or sewing, or using tools in a manual occupation. The delicate movements concerned in opposition of the thumb and fingers are lost, and in writing (owing partly to the skin anæsthesia, partly to the loss of joint-sensibility and muscular sense) the patient is obliged to grasp the pen between the middle and ring fingers of the clenched fist, and the pen every now and then is jerked away from the paper by an over-action of the extensors of the wrist.

Athetoid and spontaneous movements may occur in advanced cases.

Visceral Disturbances.—Bladder troubles are among the most constant of the early symptoms, and may be the cause of the patient seeking advice. Sometimes it is for retention, sometimes for incontinence. He may complain of a difficulty in starting the stream due to a weakness of the detrusor, or a difficulty in holding his water, a slight cough or exertion (owing to the loss of reflex tonus in the sphincter) allowing the urine to escape into the urethra, thus exciting the reflex process of micturition and the urgent desire to pass water.

In the later stages he may suffer from residual urine, necessitating the use of the catheter, and often this is attended by cystitis. From 70 to 80 per cent suffer from bladder troubles.

Bladder crises and *urethral crises* have been described, but they are rare. The patients have an urgent desire to micturate, but are unable. They experience the most severe burning and cutting pains in the urethra, and these may be associated with lancinating pains throughout the lower extremities.

Renal crises simulating renal colic from the passage of a calculus have also been described.

Gastric crises are one of the earliest symptoms of the disease, and the attacks of pain and vomiting may be the sole cause for which the patient seeks relief. In one of my cases the patient was admitted for intestinal obstruction, and the surgeon was sent for with a view to operation. It was noticed, however, that the pupils did not dilate while the patient was experiencing severe pain, and further observation showed that it was a case of tabes. In twenty-two patients suffering with tabes, out of sixty-five that I have recently seen, gastric crises were a symptom. All such cases I have found associated with complete or partial anæsthesia in the mid-dorsal region of the trunk, often with persistent girdle sensation. The attacks of vomiting may be preceded by pain or a feeling of weight at the epigastrium, sometimes occipital headache and a feeling of distension of the stomach, and lightning pains throughout the whole body. The patients usually complain of a deep internal burning sensation. Severe attacks may last several days. The contents of the stomach, if any, are vomited, but the retching of mucus continues just as in sea-sickness, often mixed with bile, and sometimes blood or altered blood. The pain may be agonising, and, although the symptoms are most distressing during the attack, it is astonishing how soon the patient recovers when it is over.

Occasionally the patients may suffer with incomplete gastric crises, in which only paroxysms of cramp-like pain of the stomach or eructations and vomiting without pain occur.

Gastric crises may be accompanied by frequent purgations.

Intestinal Crises.—Frequent watery evacuations of the bowels may take place for days, weeks, or months, and then cease as suddenly as they appeared. These are rare.

Rectal crises are relatively frequent, and often a very early symptom. The patients complain of tenesmus and urgent desire to go to stool, of severe pain in the back passage compared to a hot iron being thrust up. During the straining it is said that evacuations of blood and slime have been passed. Much more frequently the patients suffer with constipation and difficulty in relieving the bowels without purgatives. Often they are unable to keep themselves clean, especially when they have to start micturition by a strong voluntary effort, for fæces is then apt to escape owing to loss of reflex tonic contraction of the sphincter ani. Moreover, they cannot always tell when defæcation is complete.

Genital Organs.—A very early symptom is increased sexual appetite—satyriasis. This is frequently followed by impotence and atrophy of the testicles. I have noticed that impotence is often associated with loss of sensibility in the genital organs. Absence of pain on compression of the testicles is a noteworthy symptom of the disease. There may be paroxysmal attacks of priapism in the male, and cases have been described of clitoris crises in the female. Sometimes there is hyperæsthesia and sometimes anæsthesia of the vulva.

Affection of Cranial Nerves.—In rare cases the *olfactory nerve* may be affected. The patient complains of loss of smell and of the taste of flavours. Very often they experience a foul smell like a drain or phosphorus coming on in paroxysms.

Sometimes, owing to the affection of the nasal branch of *the fifth nerve,* there is loss of sensibility of the mucous membrane of the nose.

Other affections of the fifth nerve are pains, anæsthesia, and paræsthesia in various regions of its distribution. Besides disturbances of sensibility, there may be trophic disturbances, such as rapid falling out of the teeth and absorption of the alveolus of the jaw. In such cases there may be little or no anæsthesia or pain, this agreeing with the painless character of other bone and joint affections. A curious affection of the face, known as Hutchinson's mask, in which the patient feels as if the face were covered with a cobweb, is probably due to an affection of this nerve. Other rare conditions are ophthalmia neuroparalytica, corneal ulcer, tabic ulcer of the mouth, and sialorrhœa attributed to affection of the fifth nerve.

Very rarely affection of the *glosso-pharyngeal nerve* may occur, causing loss of taste.

Eighth nerve, auditory. Irritative lesions of this nerve may give rise to paroxysmal attacks of noises in the ear like rushing water, bells or steam whistles, or symptoms resembling Menière's disease, viz. paroxysmal attacks of giddiness; and later deafness may ensue.

Affections of the Vago - Accessorius.—Laryngeal crises are a pretty frequent early symptom in tabes. Paroxysmal attacks of dyspnœa and spasm of the glottis may occur. The symptoms may in some respects simulate an attack of whooping-cough or of laryngismus stridulus, accompanied by a burning pain in the larynx and a feeling of suffocation. The attacks may be very alarming, and come on as the result of breathing cold air or the passage of a sound. They may be accompanied by epileptiform seizures and loss of consciousness. In most of these cases of adductor spasm there is permanent weakness of the abductors, which, when considerable, constitutes a very grave complication. In rare cases the spasm may extend to the pharynx, making swallowing impossible.

Bronchial crises have also been described, likewise *cardiac crises,* with irregularity of the heart's action, precordial pain and constriction, a feeling of suffocation, and symptoms resembling angina; or there may be tachycardia.

The Hypoglossal nerve may be affected, causing hemiatrophy or atrophy of the muscles of the tongue.

Mental Symptoms.—A patient suffering with tabes may be the subject of potential insanity; consequently the disease may, owing to physical pain and suffering, and mental worry from physical disablement, excite in him an attack of mania or melancholia, with suicidal tendencies; or he may become the subject of paranoia, with delusions of persecution.

Such insane patients are subjects of pseudo-hallucinations and delusions, and put an insane interpretation upon the symptoms of the disease, ascribing the lightning pains in the limbs to enemies and unseen agencies having turned on electricity. The gastric and visceral crises they ascribe to poison put in their food, and unseen agencies twisting their bowels and scraping their stomach. Frequently when suffering with impotence, they have the delusion that their semen is drawn off by imaginary persons at night.

I have met with a number of cases of blind tabetics who have had visual hallucinations, usually relating to burglars, policemen, and people who are coming to do them injury. Even more common is it to have auditory hallucinations, and they hear the voices of their persecutors, who they believe are the cause of all their troubles. Some of these patients afterwards develop dementia, and die of the tabetic form of general paralysis.

The first symptom of tabes may be an epileptiform or apoplectiform seizure, followed by a transitory aphasia. The patient then may develop the characteristic signs of the disease, and for years present no further mental symptoms; or, simultaneously with the cord symptoms, mental symptoms in the form of mania or melancholia, and progressive dementia may develop, associated with grandiose delusions or delusions of persecution. The case is then recognised as one of tabo-paralysis. The cord symptoms may last years, and then the symptoms of general paralysis may develop, and very frequently, as the mental symptoms become prominent, the cord symptoms become less evident; the ataxic gait, unless advanced, gives place to a shambling, shuffling gait, and not unfrequently in these tabo-paralytics the knee-jerk may be present on one side, absent on another, and I have seen it present on both sides when there has been well-marked characteristic posterior-column sclerosis associated with lateral sclerosis. The existence of the knee-jerk on one side and absence on the other in a case of tabes is of evil omen, as it means, as a rule, cerebral destruction or degeneration. In my experience about 10 per cent of the tabetic patients become tabo-paralytics, and in asylums about 10 per cent of the general paralytics are tabetics. Occasionally hemiplegia or paralysis may arise in a subject of tabes, caused by syphilitic arteritis, but this condition is rare. Tabetics are liable also to valvular disease of the heart, and of the large vessels from atheroma and arterio-sclerosis (see also "GENERAL PARALYSIS," vol. iv.)

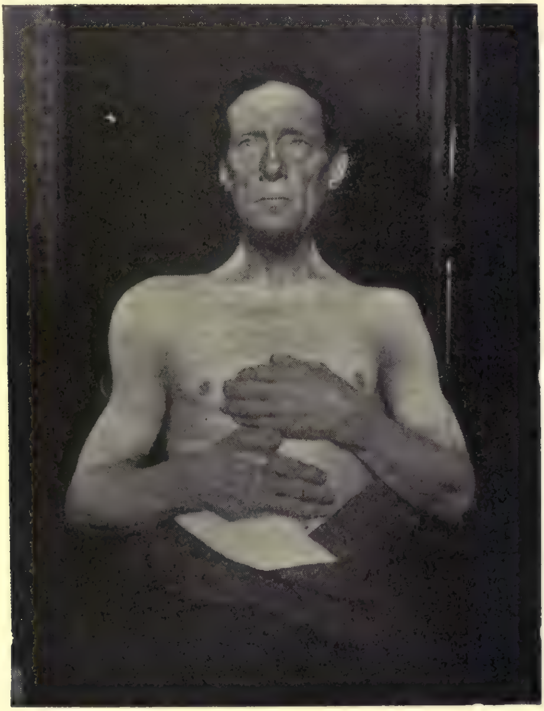

FIG. 5.—Tabo-arthropathies.

Tabo-Arthropathies.—Although there may be signs of the disease, such as Argyll-Robertson pupils and absent knee-jerks, of which the patient is unconscious, the first symptom which attracts the patient's attention may be a sudden painless swelling of a joint, possibly with dislocation or subluxation; it may have followed a trifling injury, or come on spontaneously; or the patient may suddenly, from quite an insufficient cause, sustain a fracture of one of the bones—viz. the thigh. Another form of the disease is the tabic foot; the bones of the tarsus are deformed; the foot is shortened and thicker in the instep, and the sole flattened, and there is grating on movement. As a rule, all these joint affections, as well as the fractures, are painless and unattended by fever. They are sometimes, however, painful.

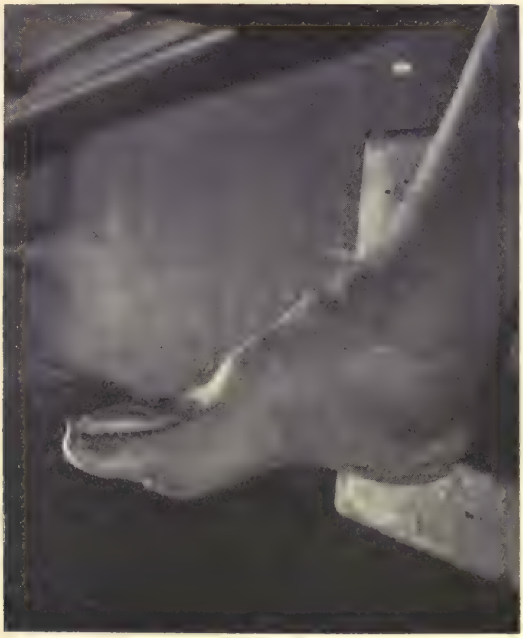

FIG. 6.—Tabo-althropathies.

The joints most affected are the knees, hips, ankles, and shoulders, but almost any joint, even the vertebral, may be the seat of the disease.

The fluid poured out into the joints which causes the swelling is serous, and very rarely undergoes suppuration, and may be so abundant as to rupture the capsular ligament, and escape into the tissues around. The articular surfaces become eroded, and even the heads of the bone may be absorbed, producing deformities and shortening. Associated with the process of atrophy there may be development of osteophytes, and it may be difficult sometimes to distinguish the disease from rheumatoid arthritis, with which it is closely allied. This joint is often called "the Charcot-joint," because of the masterly description he gave of this tabic affection.

Although spontaneous fracture occurs so readily, callus is thrown out often in abundance, uniting the ends. Sometimes tabo-arthropathy may be the sole prominent feature of the disease. I have one patient who has been so affected twenty-two years, and it is my experience that it is frequently accompanied with gastric crises, and is more common in women than in men.

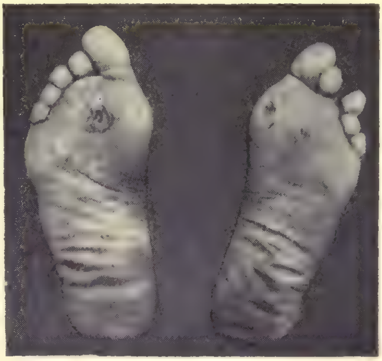

FIG. 7.—Perforating ulcer of foot.

Perforating Ulcer of the Foot.—This is a fairly common affection, and usually starts in a corn on the sole of the foot which undergoes suppuration, forming a hole as if a nail had been driven in. The ulcer is painless, but will not heal, and from it is discharged a thin, foul-smelling, purulent fluid. At the bottom of the hole there is often carious bone, and sometimes the ulcer perforates through the foot.

MORBID ANATOMY AND PATHOLOGY.—From the multiple character of the symptoms of this disease, it is obvious that multiple lesions of the nervous system may occur; and although the posterior columns of the spinal cord and the posterior roots are invariably affected to some extent in all cases, yet the morbid changes may, by no means, be limited to these structures. The peripheral nerves, both motor and sensory, may present degenerative changes; any of the cranial nerves may be affected, especially the optic, by a degenerative atrophy, and, in a certain number of cases, the cerebral cortex. The disease is, therefore, a polymorphic morbid process affecting almost any part of the nervous system, although certain structures are affected earlier and more often than others. It is therefore manifest that to speak of the disease as sclerosis of the posterior columns or leuco-myelitis posterior is incorrect.

The Naked-eye Characters of the Morbid Process.—On opening the spinal canal in a case of advanced tabes the most obvious change observable is the flattening of the posterior surface, and the thinning of the posterior roots, especially those forming the cauda equina. These roots, which are normally much larger than the anterior roots, are now smaller, being sometimes reduced to one-third of the natural size, and presenting a grey instead of a white appearance, contrasting therefore both in colour and size with the healthy anterior roots. Experiments have shown that the intramedullary projections of posterior roots form the great bulk of the fibres of the posterior columns, and this accounts for the flattening of the posterior surface of the cord; for the projections of these posterior roots in the spinal cord have atrophied like the roots. Very frequently the membranes are thickened over the posterior surface of the cord, where the atrophy has taken place, but by no means invariably, nor to an equal degree. This is important to bear in mind, because it has been considered by some authorities that the meningeal thickening is due to an irritative process, and causes the degeneration met with in the spinal cord. On taking out the spinal cord, and making a transection, the posterior column is obviously smaller than natural, and presents a grey appearance, thus contrasting with the remaining white lateral columns.

Microscopical Examination.—(*a*) Of the roots. Section of the roots of the cauda equina, stained by Weigert or Pal method, shows a more or less complete atrophy of the fibres of the posterior roots, the anterior roots appearing normal. Instead of the blue rings of myelin sheaths, are seen connective tissue and vessels. Teazed preparations of the roots, after staining with osmic acid, do not exhibit the appearances of Wallerian degeneration; the myelin sheath is either entirely absent or very much attenuated, as if the process were one of slow regressive atrophy rather than acute degeneration. Empty neurilemmal sheaths, with proliferated nuclei, fibrous tissue and vessels, showing chronic inflammatory changes, are apparent. Comparative examination of the coats of the vessels of the anterior and posterior roots shows no essential difference; moreover, the vascular changes are not constant, and are quite insufficient therefore to explain the degenerative change. In cases of prolonged tabes occurring in people past fifty, vascular changes of the nature of arterio-sclerosis or arterio-capillary fibrosis are not unfrequently met with, but this cannot explain the election of the posterior roots by the morbid process. Such degeneration of the posterior roots extends back as far as the ganglia, whence they originate.

Section of the ganglia examined by the same Weigert method show a marked contrast in the appearance presented by the proximal and distal ends, whereas, at the proximal end, the fibres emerging from the ganglion forming the posterior root may be, in great measure, or even completely, atrophied; those at the distal end, which are proceeding to form the sensory fibres of the cerebro-spinal nerves, are practically healthy and unaffected. Examination of the ganglion cells by Nissl and other methods may reveal chromolytic and other changes, even atrophy; but, as a rule, the cells of the ganglion present a fairly normal appearance, and although some authorities have concluded from their observations that the changes met with in the ganglion cells are sufficient to account for the degeneration of the posterior roots, yet most authorities are of opinion that they are inadequate and inconstant. The farther the peripheral nerves are examined from the ganglia the more likely are changes to be found; consequently, in advanced cases of tabes, atrophy of the small nerve fasciculi in the skin may be observed, also the nerves of other structures, such as muscle (which contains a large number of sensory fibres); but these peripheral nerve changes only occur, as a rule, in advanced cases, and are quite insufficient to account for the symptoms. The spinal element of the disease is essentially due primarily to an affection of the intra-medullary projections of the posterior roots, afterwards extending back as far as the ganglion of origin. *Vide* diagram, Fig. 8.

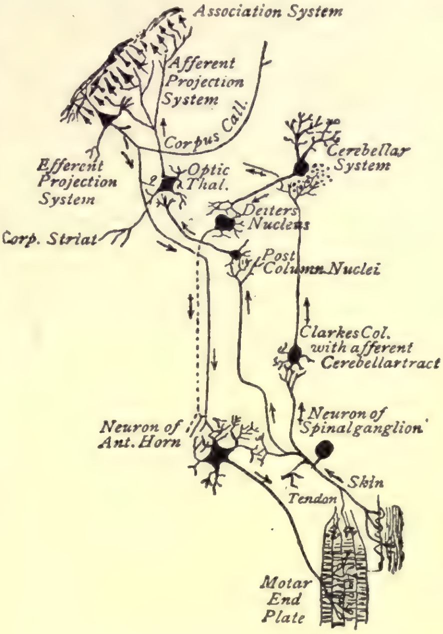

FIG. 8.—"Sensibility."

The segmental character of the anæsthesia occurring in tabes supports the view of Leyden, that it is *a segmental spinal affection.* But ataxy may occur without any anæsthesia, showing that the fibres conducting cutaneous sensations in the cord have not been affected; but the fibres conducting muscular sense, joint and tendon impressions have been affected, so as to produce the ataxy. Pierret and Charcot long ago showed that a certain portion of the postero-external column, which they called the "bandelette," is the earliest affected in tabes; and, as we shall show, the fibres in this region, convey sensory impressions to the anterior horn cells and to the cerebellum by way of Clarke's column. The former are concerned with the reflex spinal tonus, the latter with afferent impressions enabling us to maintain our equilibrium; so that destruction of these fibres alone would account for ataxy and loss of deep reflexes apart from cutaneous disturbances.

A posterior root on entering the spinal cord terminates in three sets of fibres—a set of short fibres which end almost immediately in the spinal segment to which the root belongs. This set of fine fibres forms Lissauer's tract, and ends in the substantia gelatinosa of the posterior horn. These fibres are probably concerned with cutaneous sensibility, and may be partially or completely atrophied according to the stage of the disease, and the degree of disturbance of cutaneous sensibility.

Next, there is a set of coarse fibres of medium length which enter on the inner side of the posterior horn, in what is called the "cornu radicular zone." These pass forwards and upwards, being pushed forward by the fibres of the next entering root, and they come to occupy the anterior and middle portion of the postero-external column, sending fibres which break up into collaterals in the grey matter (*a*) around the cells of the anterior horn (*b*), around the cells of Clarke's column.

There is yet a third set of long fibres which pass forwards and towards the mid-line to enter the posterior median column. In the case of the lower extremities these fibres form the column of Goll, which run up the whole length of the spinal cord to end in the cells of the funiculus gracilis.

These three sets of fibres forming the greater part of the posterior columns may be looked upon respectively as the first afferent channels for spinal, cerebellar, and cerebral impulses. Each root contains fibres conveying impressions to each of these termini, and the three together are essential for perfect motor action and coördination. Their disease interferes with the guiding impressions coming from the joints, tendons, muscles, and skin essential for perfect locomotion and motor activity; but in the posterior columns of the spinal cord there are other sets of fibres which have their cells of origin within the grey matter; these are endogenous association fibres serving to link up the spinal segments of different regions of the cord. They are affected, but at a much later date than the exogenous fibres, and no doubt it is their affection which leads to severe ataxy and eventually the complete helplessness of the paralytic stage of tabes.

These endogenous fibres are ascending and descending and occupy four regions of the cord: (1) the comma tract; (2) a triangle to the inner side of the posterior horn; (3) a region corresponding to the anterior portion of the posterior column called the cornu-commissural zone. In the lumbar region (4) a small oval area is found occupying the middle line of the posterior column, the fibres of which pass backwards in the sacral region to form a small triangle.

The whole of the exogenous fibres may be destroyed, also nearly the whole of the endogenous, but it is rarely that some of the endogenous fibres cannot be found in the cornu-commissural zone.

Occasionally atrophy of the cells of Clarke's column occurs with degenerative atrophy of the cerebellar tracts. Occasionally the anterior horn cells show atrophic changes, especially certain groups supplying the small muscles of the hand or the muscles of the feet and legs; as a rule, however, the anterior horn cells fibres and roots are normal.

In some cases, especially where there have been changes of the cerebral cortex, degeneration in the pyramidal tracts may be found. This is the rule rather than the exception in tabo-paralysis.

In arm-tabes the posterior roots which enter into the formation of the brachial plexus are affected, and in rare instances the lumbo-sacral roots are not affected. The same three sets of fibres in the spinal cord undergo degeneration and atrophy, but a section of the cord in the cervical region would, in such case, show no degeneration in Goll's column. The long set of fibres conveying impulses which will eventually reach the cerebral cortex, occupies a position in front of and overlapping the triangle of fibres forming Goll's column. These proceed to Burdach's nucleus in the medulla.

Atrophy and sclerosis of any of the cranial nerves may occur, accounting for the symptoms observed during life, but the most frequent and the most important is the grey atrophy of the optic nerve, which is associated with no apparent change in the vessels. It is a progressive atrophy of the fibres back to the ganglia cells of the retina, which in prolonged cases may even themselves undergo atrophy.

The Argyll-Robertson pupil which, as we have seen, is the most important sign of the disease, has so far not been satisfactorily explained. It is said that there is an atrophy of fibres of the corpora quadrigemina, and that thereby impulses produced by light stimuli traversing the optic nerve, are interrupted in their passage to the motor nucleus of the sphincter iridis. This, however, in the writer's opinion is not sufficiently demonstrated to be acceptable.

Cerebral Cortex.—Atrophy of the tangential and supra-radial fibres of the cerebral cortex have been described by many authorities. Undoubtedly some of the cases may have been incipient tabo-paralysis; others may have been true tabes or tabes with mental symptoms; it is quite possible that in prolonged cases of tabes that an associated atrophy of such structures physiologically correlated may occur.

Diagnosis.—A patient suffering with tabes will in all probability seek advice, not for the characteristic signs which differentiate the disease from all other diseases, but on account of some subjective symptom which causes him pain, discomfort, or interferes with his occupation or business. A mistaken diagnosis in general arises, not from the practitioner not knowing, but from his not looking for the characteristic signs, namely, the Argyll-Robertson pupils, absent knee-jerks, sensory disturbances of the skin, and Romberg's sign. In this way the lightning pains may be mistaken for neuralgia, the gastric crises for functional disturbance or organic disease in the stomach; the true nature of spontaneous dislocations and fractures may be overlooked; bladder troubles may be attributed to organic disease, with which, of course, sometimes the tabic condition is associated. The doctor, when called to a case of tabes suffering with severe pains, will notice that the pupils are not dilated; and I have already alluded to a case of gastric crises with distended bladder and suppression of urine admitted to the hospital, and the surgeon sent for with a view to operation. It was noticed in the paroxysms of pain that the pupils still remained contracted; other signs of tabes were then found, and the patient recovered without any surgical interference. Another case came under my observation in which abdominal section had actually been performed. In the case of visceral crises, the differential diagnosis can be made by attending to the mode of onset, the duration and mode of subsidence of the attack, the normal condition of the affected organ between the paroxysms and the presence of other symptoms and signs which are characteristic of the disease. It must be remembered that all these conditions for which a patient may seek advice can and do occur in the pre-ataxic stage, and that the knee-jerks are not necessarily absent, although usually so.

Another very early symptom, as already pointed out in the symptomatology, is a transitory ocular paralysis; this, in conjunction with Argyll-Robertson pupils and one of the other signs or symptoms is sufficient to warrant a diagnosis of tabes; again, the first symptom of tabes may be defective vision, and opthalmoscopic examination may discover commencing optic atrophy; if this is combined with one or more symptoms or signs, tabes may be diagnosed; and even with only primary optic atrophy, and no other symptom or sign, tabes or the closely allied, if not identical morbid process, general paralysis, may be anticipated.

Certain cases of multiple neuritis which are termed the pseudo-tabic form, arising from alcoholic, arsenical, diphtheritic, and even typhoid poisons may be mistaken for true tabes; some of these cases of pseudo-tabic neuritis have been reported as locomotor ataxy which have got well; in none of these, however, is the Argyll-Robertson pupil present; and a careful investigation of the signs and symptoms will show that they do not correspond entirely with those of tabes.

The ataxy occasioned by a cerebellar tumour might be mistaken for tabes; there is, however, in such a disease occipital headache, optic neuritis, absence of lightning pains, and usually the presence of knee-jerks. There may be post-neuritic atrophy in cerebellar tumour, but the small size of the vessels will distinguish it from the primary optic atrophy of tabes.

Hysterical ataxy can be differentiated by attention to the fundamental signs and symptoms of tabes.

Hereditary ataxy (Friedreich's disease) affects several members of a family; the characteristic pupil phenomena of tabes are absent, and although there may be marked ataxy, there is no disturbance of cutaneous sensibility.

Syringomyelia may in some cases present symptoms like those of tabes, but there is usually wanting the characteristic signs of the pupils, the lightning pains, the absent knee-jerks; moreover, the sensory disturbances are unlike those of tabes, touch being appreciated, but pain and heat and cold not, and there are frequently degenerative muscular atrophies.

The disease which is most likely to be mistaken for tabes is the tabetic form of general paralysis; in fact, a number of cases of tabes become general paralytics, and a certain number of general paralytics may develop tabic symptoms; in the writer's opinion the two diseases are one and the same morbid process affecting different parts of the nervous system.

The question as to whether mental symptoms are present in a case of tabes is one of great importance in diagnosis, because of the serious consequences that may arise, and the necessary steps to be taken in the interests of wife, friends, and relations to prevent social difficulties arising. A tabetic patient may become irritable and addicted to alcoholism on account of his infirmity, and the symptoms may suggest the onset of the more serious brain disease. A family history of insanity will make that more probable; but even then, not necessarily does it warrant a diagnosis of general paralysis, although such a condition must be anticipated and the friends warned of the danger. Again, in locomotor ataxy excessive sexual passion may arise in the early stage of the disease, and involve social difficulties and even criminal charges.

A man suffering with ataxy, especially with a psychopathic history, may develop mania, melancholia, or paranoia, and usually put an insane interpretation upon the symptoms from which he suffers. It does not necessarily follow, therefore, that he is a general paralytic. The feature of this disease — general paralysis — is not necessarily grandiose delusions, although such is very frequently the case; there may be extreme mental depression with delusions of persecution. The speech is not necessarily affected, nor the handwriting in the earliest stages of the disease, although sooner or later it will be. The one characteristic symptom is *progressive dementia* with some change of character.

PROGNOSIS AND COURSE.—Tabes rarely ends fatally in a few years, unless as a result of some intercurrent disease or the onset of general paralysis. Patients may live thirty years or more after the first onset of symptoms; ten to fifteen years is probably a fair average after the symptoms have become pronounced. If a patient suffers with continuous bladder trouble and cystitis through neglect of catheterisation when there is residual urine, he is apt to develop pyelo-nephritis, which may terminate fatally. Again cystitis too often arises from the use of a dirty catheter; too much care, therefore, cannot be exercised in attending to this detail—so important in the treatment. One feature in tabetic cases is the marasmus, partly due to the influence of the withdrawal of sensory stimuli or muscular metabolism, partly to the pains, gastric crises, and often to the drugs such as morphia, etc., taken to relieve them which interfere with assimilation and nutrition.

In the third paraplegic stage, when the patient is bedridden, or when he is obliged, from diseased joints, to take to his bed, bed-sores are liable to supervene and give rise to septic infection. Such patients in their weak exhausted state are more liable also to a low form of pneumonia or broncho-pneumonia, which may end fatally. Occasionally a patient may die from laryngeal spasms with epileptiform convulsions. Death may arise from aneurysm, valvular disease of the heart, chronic Bright's disease, or bronchitis and emphysema with which the tabetic condition may be associated. For the conditions which give rise to tabes also tend to chronic arterial degenerative changes.

The PROGNOSIS is *unfavourable* in all cases, for the disease in most instances is progressive; it cannot be cured, it can seldom be arrested; the cases of supposed cure and very often of supposed arrest of the disease are often merely an alteration of the subjective attitude of the patient towards the symptoms from which he suffers under the influence of suggestion of a new doctor with a new specific. Cases, however, do occur in which the disease remains *in statu quo* for a great number of years, or even show symptoms of improvement; opthalmoplegia passes off, bladder troubles cease, laryngeal crises no longer occur, and the writer has met with cases in which pains or gastric crises have been very severe for numbers of years and then become less and less marked. As a rule, however, the pains last during the whole course of the disease; it is remarkable that a large number of cases commencing with optic atrophy, remain, as Benedikt, Gowers, Marie, and Déjerine have pointed out, in the preataxic stage. The writer has already alluded to his experience in this, but he has also pointed out how frequently such cases of optic atrophy become tabo-paralytics. It is a fact that with the onset of dementia in tabo-paralysis, the ataxic symptoms and lightning pains markedly diminish and even altogether cease, as if the affection of the brain was associated with an arrest of the spinal disease.

TREATMENT.—No drugs can replace the degenerated nervous tissue, nor prevent the premature decay with which certain structures of the nervous system are affected; when once the disease has manifested itself, the first indication is to adopt such measures as will lead to arrest of the rapid development of the morbid process upon which the symptoms of the disease depend. We have already emphasised the importance of stress as a contributory factor in the production of the disease; therefore all occupations involving muscular fatigue should be avoided if possible. Prolonged standing, exposure to wet, cold, and changes of temperature are all liable to injurious consequences; and worry, excitement, and the stress and mental anxiety associated with business responsibilities, are liable to lead to aggravation of the disease; but of all the causes against which the patient should be warned, excesses *in Baccho et Venere* are the most important. In fact, all conditions which would tend to neurasthenia are to be avoided.

We have already seen that the toxine of syphilis is acknowledged (by most authorities) to be the most important, if not the essential cause of this disease; one would expect mercury inunction or a course of iodide of potassium, as in syphilitic diseases, to produce beneficial results. As a matter of fact, it is seldom that this course of treatment does any good; sometimes it does harm, lowering the patient's strength and aggravating the disease; still there are some cases in which a course of inunction judiciously applied, or iodide of potassium in 10 or 15 grain doses, combined with a drachm of Liquor Hyd. Perchlor. is advisable. These are early cases of optic atrophy or ocular paralysis, or cases in which the symptoms have come on within five or six years of syphilitic infection, especially if the patient has not before been treated by a course of mercury. The writer has seen a few cases improve upon this treatment.

The remedies that are usually employed with some measure of success are arsenic and strychnia, either separately or in combination. Nitrate of silver in olden times was a favourite remedy in the form of a pill; it had the disadvantage of producing argyria and consequently has fallen out of use. The coal-tar preparations, antifebrine, antipyrine, phenacetin, exalgin, are in many cases very successful for alleviating the pains. The writer has found antipyrine the most successful in 10 to 15 grain doses, repeated every hour or two for three doses. Methylene blue in 1 grain doses; chloride of aluminium in 2 to 4 grain doses; and salicylate of soda in 15 to 30 grain doses in combination with Tincture Cannabis Indica have been found useful; this latter drug may also be combined with any of the coal-tar preparations. It is well not to employ morphia if it can be avoided, and,never put into the hands of a patient the hypodermic syringe, or a worse condition even than the disease may be produced.

In gastric crises the before-mentioned drugs may be tried, but as a rule, morphia is the only remedy which is efficient in severe cases, although oxalate of cerium in 2 to 5 grain doses may be tried.

Electrical treatment.—Galvanism has been recommended, one electrode being applied to the neck, the other to the lumbar region of the spine, a current not exceeding 5 to 8 milliampères being used, or the current may be applied by moving an electrode down the spine (labile), or made to pass right down the spine, both electrodes being fixed (stabile).

Erb's method.—The kathode of medium size is fixed over the superior cervical sympathetic ganglion, then the larger anode is moved down the opposite side of the verterbral column close to the spinous processes in the lower cervical and upper dorsal regions. By either method the sitting should not be more than five minutes.

Faradism.—A large electrode is placed on the thorax or neck, whilst the brush is stroked over the skin of the buttocks and lower extremities or over the anæsthetic areas. The strength should be enough to be just painfully appreciated by the patient, but not to cause muscular contractions. The sitting should not occupy more than ten minutes.

Some authorities recommend the actual cautery over the spine, especially when there is pain in this region.

Aconitia ointment and hypodermic injections of cocain $\frac{1}{4}$ to $\frac{1}{6}$ grain or menthol liniment may be employed to relieve the pains of hyperæsthetic cutaneous areas.

Hydrotherapy.—Cold douches and simple warm baths, natural thermal springs, and springs containing carbonic acid are used in Germany, but have not found much favour in England. The baths of Mannheim and Wildbad are recommended. The hot mineral water baths of Bath, and hot brine baths of Nantwich and Droitwich might be recommended.

Mechanical Treatment.—About twenty years ago nerve-stretching was introduced; benefits and even cures were said to result. This treatment, as well as suspension and bloodless nerve-stretching have by experience been found to be useless. The latter carelessly applied has led to fracture. These methods when they have done good, have probably merely affected the subjective attitude of the patient towards his disease, and have not had any real effect upon it. They are not, however, free from the possibility of injurious results.

Massage and Gymnastics are useful in some cases, and certainly benefit has resulted from Frenkel's method of exercises. The patient is made to learn again the movements by the aid of vision; gradual transitions from simple to more complicated movements are practised under the guiding direction of vision, while he is lying, standing, and walking. When the patient is in an advanced state of locomotor ataxy, and when presumably the association systems of neurons of the spinal cord, as well as of the exogenous systems, are destroyed, little good can come from this mode of treatment; but prior to this, undoubtedly much benefit, and even a return of useful coördinate movement can in many cases be accomplished by a systematic adoption of this principle of opening up new paths and new associations under the direction of vision. Care must be taken, however, not to fatigue the patient.

It is of very great importance not to alarm the patient, yet at the same time to frankly confess that you are of opinion that he is suffering from an incurable disease, which will progress slowly or quickly according to his mode of life. If he gives himself up to indulgencies *in Baccho et Venere*, and neglects the warnings as to exposure, fatigue, mental or bodily, the disease will certainly progress more rapidly; his general nutrition must be maintained by generous, but not excessive diet; iron, arsenic, or strychnine in the form of pill may be administered, if he suffer from anæmia or anorexia.

He should be told to empty his bladder regularly; and not to allow more than four hours to elapse, so that atonic distension may be avoided. Care should be taken that he does not suffer from residual urine from want of use of a catheter, but the greatest precautions should be exercised to use a perfectly aseptic instrument. Smoking should be avoided if there is optic atrophy; in any case, moderation in tobacco should be strictly enjoined. He should be told that if he suffer with corns, he should not cut them, but soak them in warm water and carefully rub them down with pumice stone, otherwise he may suffer from a suppurating corn and perforating ulcer which will never heal. Owing to the liability to joint affections and spontaneous fracture, he should not attempt to walk without support, if he is ataxic; as a slight injury may lead to a serious result, in the form of spontaneous dislocation or fracture. It will thus be seen that the pathology of the disease teaches us that there are many symptoms and complications for which the doctor's aid may be called, and in relieving these and as far as possible comforting the mind of the patient and averting further morbid developments by judicious advice, he fulfils, as far as he is able, his duty towards the patient, for he is powerless to restore the nervous tissue which has been destroyed, and, indeed, is in great measure powerless to avert the progressive degenerative change of further nervous structures; in fact there is no part of the nervous system which may not be eventually affected in this disease; and the name of *Tabes* best expresses its character, and implies also that the treatment is symptomatic rather than curative.

Tabes Mesenterica. *See* Mesenteric Glands.

Tachycardia. *See* Heart, Neurosis of.

Tape Worms. *See* Parasites.

Taste. *See* Glosso-Pharyngeal Nerve.

Teeth.

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Teeth are hard, calcified organs of variable shape, size, and condition of calcification. In man and the mammalia generally, teeth are only developed in the mandible and maxilla, whereas in Reptilia and Pisces teeth are also found on the tongue, palate, pharynx, etc.

Teeth are derived from the epithelial tissues of oral cavity, epiblast, and mesoblast layers, and thus belong essentially to the tegumentary or dermal system. This analogy of the tissues is well exemplified in the lower vertebrates where the gradation between teeth, bony plates, scales, spines, etc., is well shown. In some cases in the human subject deficiency of teeth is accompanied by want of, or deficiency of toe nails, finger nails, and hair.

Function and Forms of Teeth.—The principal function of teeth in most animals is to aid in the preparation of their food for digestion, or for holding or tearing their prey preparatory to swallowing. But they subserve other purposes: speech and appearance in man; attack and defence in the carnivora. The extinct Dinotherium, with its two long, curved tusks projecting downwards in the mandible, used them for digging up roots upon which it fed. The walrus helps itself along over the slippery rocks by means of its tusks, while the beaver, with its powerful jaw and chisel-shaped teeth, is able to cut down the hardest of trees with which to form its dam. The serpents use their teeth for retention of their victims, while the poisonous ones are also able to paralyse previous to swallowing; their teeth are also used for defence. The teeth of fishes are largely used for prehension, or for tearing their slippery prey. The function of some teeth is difficult to make out. For example, the wart-hog (*Sus Babirussa*), with its two recurved teeth passing upwards and backwards over its skull, which they sometimes penetrate. Layard's whale (*Mesoplodon*) has also a curious arrangement of teeth, which passes from the mandible upwards and backwards, crossing each other from left to right over the beak of the animal.

The forms assumed by teeth are very diverse. Teeth, or organs analogous, are found in the gizzard of the common crab and in some insects, notably the cockroach of our kitchens. In several of the Protozoa a complicated arrangement of tooth-like bodies are found. The garden snail has a crescentic jaw-plate in the roof of the mouth and the radula, a membranous ribbon bristling with teeth in the lower, the radula being used as a saw for cutting down leaves, etc., upon which it feeds. The whelk of our shores has its tongue or lingual ribbon bristling with a regular arrangement of sharp-pointed teeth. The echinus or sea urchin has at the entrance to its oral cavity five sharp-pointed teeth, which are implanted in separate movable portions of the jaw. The teeth grasp the food, and it is then passed on to be ground down by the movable segments of the jaw. In the higher vertebrate fishes simple conical teeth abound, the highest form being found in the pike with its bristling array of strong, curved, pointed teeth, or in that of the wolf fish (*Anarrhichas Lupus*) with its powerful jaws and caniniform teeth in front, for tearing from the rocks shell-fish, and its equally powerful, pavement-like, crushing teeth behind. In the skate family flattened plates generally represent the teeth, several of the rays having in addition a sharp-curved denticle growing out from the plate. The shark possesses a wonderful armament of teeth, composed of a series of triangular serrated flattened cones arranged tier upon tier in the two jaws, and attached to the tough fibrous membrane covering them. Their teeth are constantly being renewed as the marginal ones drop off. The next row takes their place. This is brought about by the upward movement of the membrane carrying the teeth. Some of the extinct sharks had enormous teeth, and must have been very formidable animals. The myxine has a single pointed tooth in the palate, and two serrated plates upon the tongue. The tench has one grinding tooth on the occiput, opposed to which are two jaws in the pharynx below, which carry teeth. Some fishes have the bones of the forepart of their head blended together, forming a kind of sharp-cutting beak. This is well shown in the globe fish (*Tetrodon fahaka*). Other toothless fishes are the sturgeon, padde fish, etc.

Reptilia and Batrachia.—In this group of animals are found some remarkable forms of teeth, exhibiting, however, only a higher development of the cone. The teeth are neither so numerous, nor so widely distributed upon the bones of the oral cavity, as in fishes. Nearly all Batrachians and Reptiles have a constant succession of teeth, with the exception of some of the lizards (*Hatteria*). Generally, they possess two rows of teeth extending backwards beyond the line of vomerine teeth. The Australian lizard has broad, crushing spheroidal crowns to its teeth instead of points.

The toad is edentulous, while the frog has only one row of short teeth upon the margin of the maxilla; there are none present in the mandible. The teeth of the newt and salamander are very similar to eels, and are tipped with enamel. The siren has on its mandible a horny sheath and several rows of small teeth, while the maxilla is toothless. The extinct Batrachian Labyrinthodon was an enormous animal. It had rows of very large pointed teeth in the mandible and maxilla, and also palatine teeth. The structure of their teeth is most interesting. The whole tooth is made up of dentine, and presents a series of pulpules, with numerous dentinal tubules radiating from the centre of pulpule to the periphery, and intercommunicating with the systems in their neighbourhood, producing a most elaborate pattern when viewed by the microscope. Turtles and tortoises have no teeth, but the margins of their jaws are sheathed in horny cases. The vegetable feeders have blunted margins to their jaws, the carnivorous having sharp margins.

Crocodiles, gavials, and alligators have their jaws armed with powerful sharp conical teeth, which vary much in form and size in the different species. In the crocodile the number of teeth seems to remain the same throughout its lifetime, but they increase in size with age. The teeth are lodged in distinct sockets, and are constantly being renewed; the successional teeth in various degrees of development lie telescoped, one within the other, in the hollow root of the tooth, so that when one is broken or worn out, the next in succession replaces it. Among lizards there is great variation in the form of their teeth, some being blunt and rounded, others have thin serrated edges. The successional teeth are developed at their inner bases. The monitor lizard has a complicated arrangement of the pulp in its teeth, which divides into a number of processes at their base. Vascular dentine, so common in fishes' teeth, is likewise found in the teeth of some saurians. The enormous extinct Iguanodon had powerful palmate-shaped teeth—the inner side composed of vaso-dentine, the middle of dentine, while the other serrated surface is enamel only.

Aves.—None of the known species of birds possess true teeth, although numbers of them have tooth-like bodies on their mandibles, such as the motmot and toucan. The plant cutters, Phytotomidæ, have, in addition, tooth-like bodies in the interior of their mandibles as well. Parrots in the fœtal condition are said to possess germs of teeth, which, however, disappear later on. Of extinct birds there are several which had true teeth, as we learn from Professor Marsh. The Ichthyornis was described by him in 1872. Both jaws were furnished with compressed pointed teeth covered with enamel; there were forty-four in the mandible, and an equal number in the maxilla, and these teeth were fixed in distinct sockets. Another gigantic bird with teeth was the *Hesperornis regalis*; its teeth were planted in a groove extending the whole length of the mandible, and had sharp-pointed crowns covered with enamel, and supported on strong fangs.

Mammalia.—In nearly all the mammalia there are present definite sets of teeth, of constant number, form, and position. Some, however, only develop one set of teeth, and are called Monophyodont—the armadillo and sloth being examples. The larger proportion of mammals have a primary and secondary series of teeth; no animal, so far as is known, having more than two sets of teeth. Animals which have two sets of teeth are termed Diphyodont. The simplest form of mammalian tooth is found in the dolphin, with its numerous single-rooted, conical-pointed, homodont teeth, there being no successional teeth; it is also monophyodont. In the majority of mammalia the teeth present certain definite shapes which are characteristic of all of them. Thus, in the premaxilla there are present four single-rooted, cutting teeth incisors, then come the prominent canines, premolars, and molars, the latter of which subserve the purpose of grinding down food; dentitions like that of man are termed Heterodont. The typical mammalian dentition may be put thus:—$\mathrm{I}\,\frac{3}{3}\;\mathrm{C}\,\frac{1}{1}\;\mathrm{Prm}\,\frac{4}{4}\;\mathrm{M}\,\frac{3}{3} = 44$.

A peculiarity of some mammalian teeth is that of persistent growth. This is exhibited in the teeth of Rodentia—beaver, rat; also in the molars of the sloth, tusks of Babirussa, and elephant. Such teeth, though worn down at the point, continue to grow from the pulp at their base, and thus make up for loss. When from any cause the normal wear of the tooth is prevented, they sometimes grow so long as to prevent the use of the jaws, and death from starvation ensues.

Mammals may be roughly divided into classes thus: (1) Carnivora, (2) Proboscidea, (3) Ungulata, (4) Rodentia, (5) Edentata, (6) Marsupialia, (7) Insectivora, (8) Chiroptera, (9) Quadrumana.

Land Carnivora.—Dental formula I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{2}$ M $\frac{1}{1}$ = 30. This type of dentition is well shown in the Felidæ, which have short powerful jaws, with strong muscular attachments ; the incisors are small, so as not to interfere with the use of the sharp-pointed, prominent, trenchant blades of canines, which are used for seizing and killing their prey. The molar teeth have irregular ridges, and articulate with each other like scissor blades ; they are used by the animal for removing the remainder of the soft tissues from the bones of their victims, and likewise for crushing the smaller bones. The other members of this family—dogs, cats, hyænas, racoons, and bears—all possess modifications of the same dentition adapted to suit their varied requirements and purposes.

Marine Carnivora.—The teeth of this group of animals are well exemplified in the dolphins and seals, with their long, narrow mouth, wide gape, and numerous subequal, conical, sharp-pointed teeth, well adapted for seizing and retaining their slippery prey. The dolphin has some 200 teeth in its jaws, which interdigitate with each other.

The walrus, *Trichechus Rosemarus* (dental formula, I $\frac{1}{0}$ C $\frac{1}{1}$ P $\frac{3}{3}$), has a very peculiar dentition, in the form of two enormous upper canines, which incline downwards beyond the lower lip. They are teeth of persistent growth, and are composed principally of dentine, with a thin coating of cementum. The walrus uses these great tusks in tearing from the rocks the shell-fish and seaweed upon which it feeds, and its tusks are also used to assist it in progression over the ice and rocks ; the male is said to use them as sexual weapons. The sperm whale has a good armament in the mandible, of conical enamel tipped teeth, some 40 to 60 in number, and only a few stunted teeth in the maxilla. The so-called toothless, or whalebone whale, in the fœtal condition, has present in both jaws a series of calcified teeth, which, however, are destroyed by absorption prior to birth. In the adult condition the baleen plates, which hang down from the palate, represent the teeth, each baleen plate being developed from a vascular papilla.

In the narwal (*Monodon monoceros*) only two canine teeth are found in the maxilla. In the female, although these teeth grow some 8 inches in length, they never erupt. In the male one tooth (rarely two) continues to grow from its persistent pulp till it attains the length of some 10 to 12 feet ; this tooth is always the left canine, is quite straight, and is marked by spiral grooves, winding from left to right. The functions of this curious tooth are supposed to be for spearing fish upon which it preys, it is said also to be used for making air holes in the ice during winter.

Proboscidea.—There are only two living representatives, the Indian and African elephants. Indian elephants have two tusks, incisors, in the maxilla, composed principally of dentine, the ivory of commerce. They are less in size in the female than in the male ; they have molars $\frac{6}{6}$, which are very large, and are composed of irregular parallel plates of enamel and dentine, fused together with cementum from before backwards ; the enamel plates number from 4 to 27. African elephants differ in many respects from Indian. The tusks are large in both sexes ; the molar teeth present lozenge-shaped plates, and the number of plates is very much reduced. Of extinct Proboscidea the well-known mammoth, *Elephas primigenius*, possessed two enormous tusks 8 feet long, strong, thick, curving upwards and backwards, and altogether was a much larger animal than any known elephant. The mastodon, another extinct animal, resembled the elephant, the molars, however, being much simpler in character, more tubercular, and free from cement. It had two small tusks, incisors, in the mandible.

Ungulata.—As examples of this class we might take the horse. Dental formula, I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{4}{4}$ M $\frac{3}{3}$ = 44. The incisors present a curious dipping down of the enamel, constituting the pit or peculiar mark, from which horse dealers are able to tell the age of any animal they inspect—the regular rate in which it is worn down in the different incisors indicating this. This mark is due to the inflection of the enamel, or a raising up of the singulum. The incisors meet with an edge to edge bite, causing a rapid wearing away of the teeth. The molars are long and strong, the enamel plates assume very intricate patterns, the interspaces being filled up with cementum. As the teeth get worn down they continue to grow, though they have not persistent pulps.

Rhinoceros.—Dental formula, I $\frac{2}{2}$ C $\frac{0}{0}$ Prm $\frac{4}{4}$ M $\frac{3}{3}$. This dentition differs in many respects from that of the horse. The molars are of very intricate pattern, though not so complex as that of the horse, and present a rough, raised surface admirably adapted for grinding the tough roots, etc., on which it feeds.

Wild Boar.—Dental formula, I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}$ = 40. The upper incisors stand apart from each other. The same teeth in mandible stand straight up, in an almost horizontal position; the canines are large, conical, and prominent, and have persistent pulps. The maxillary ones incline downwards, then outwards and upwards; the lower ones, outward and upwards; the molars increase in size from before backwards, their masticating surfaces presenting rounded conical cusps. Another member of the family, *Sus Babirussa*, is remarkable not only for having enormously long maxillary tusks, canines piercing the upper lip, and curving upwards and backwards, but also for the curious structure of their last molar teeth; these are very massive and composed of prisms of enamel, surrounding a central mass of dentine, embedded in the cementum which unites them into one tooth.

Rodentia.—The capybara is the largest rodent. The molars and incisors grow from persistent pulps. Molars $\frac{4}{4}$ are large in size, and are composed of a series of irregular plates of dentine and enamel fused together with cementum. The incisors are long and scalpriform, and have persistent pulps. Enamel is only present on the front surface of the tooth, which keeps the tooth always sharp, by the wearing away of the softer dentine behind. In hares and rabbits the molars have persistent pulps, but in cats, mice, and beavers the teeth have roots; there is a wide diastema between the incisor and molar teeth, and sometimes between premolars and molars.

Edentata.—This name was given to animals in which there are no incisors present in the intermaxillary bone. This though true of most of them, a few have upper incisors, the centrals in all cases however being absent. As a rule the dentitions in this group are homodont or monophyodont, except the two-toed sloth. The teeth are very simple in form, and do not differ to any extent, except in size, in the various parts of the mouth. The teeth have persistent pulps, and consist chiefly of dentine and vaso-dentine. The armadillo has on an average some 32 teeth; priodon, 100 teeth. Sloths have 18 teeth principally composed of vaso-dentine.

Marsupialia.—The typical marsupial dentition is I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{4}{4}=44$. They are peculiar in having only one deciduous tooth, a molar on either side of the jaw. They all possess tubular enamel except the wombat. The dental formula of this animal is I $\frac{1}{1}$ C $\frac{0}{0}$ Prm $\frac{1}{1}$ M $\frac{4}{4}=24$. Its dentition greatly resembles the rodent type. Like them it has large chisel-shaped incisors, covered with cementum, and with long fangs growing from persistent pulps; its molars also are of persistent growth, and it has no deciduous teeth.

Insectivora.—The best-known animals in this class are hedgehogs, shrews, moles, and flying lemur. In the hedgehog the dental formula is I $\frac{3}{3}$ C $\frac{0}{0}$ Prm $\frac{4}{3}$ M $\frac{3}{3}$ $=38$. In the maxilla there is a wide space between the central incisors, which are caniniform in shape and larger than the others; all the other teeth up to the third molar resemble premolars in shape. The fourth premolars and the three molars have strong square crowns, with four well-defined cusps, and have each four roots. In the mandible the teeth present similar appearances, but are rather smaller in size. Another member of the family, the flying lemur, *Galeopethicus*, has a very curious dentition. The mandibular incisors are divided by a number of longitudinal divisions, giving an appearance similar to that of a comb. It has a well-marked primary dentition. The teeth of Insectivora have all a very thick coating of enamel, and pigmentation of this tissue is well marked.

Chiroptera are divided into Insectivorous and Frugiverous. Dental formula of first, I $\frac{2}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}=38$. The insectivorous bats have very small incisors, rather large canines and premolars; the molars are covered with sharp cusps similar to insectivorous teeth; some develop milk teeth, others do not. The vampire bat, *Desmodus*, has a specially modified dentition. It has only one incisor on either side, which is large, but thin and sharp edged, and with which the wound is made. The inferior incisors are small and slightly notched, the canines large, but the posterior teeth are somewhat dwarfed. Frugiverous bats, dental formula, I $\frac{2}{2}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}$. The teeth have a diastema between them, the incisors small, canines rather large; both premolars and molars are of a simpler form, slightly compressed, and have slight cusps on their outer surface.

Quadrumana.—This group embraces lemuridæ, lemurs, simidæ, old and new world monkeys, and anthropidæ, man. The lemur is a native of Madagascar, and its dentition differs somewhat from that of the monkeys. The majority of them have the maxillary incisors very small and widely separated from each other. In the mandible there are present four long, thin, narrow incurved incisors, and two canines; the premolars are narrow, sharp teeth, the molars armed with long sharp cusps. The maxillary molars in many lemurs have four cusps connected by an oblique ridge, as in man and monkeys. A curious member of this family which both in appearance and in its dentition approaches closely that of the rodent, is found in the aye-aye (*Chiromys*). It has a pair of narrow, curved, upper and lower incisors, which grow from persistent pulps. Owing to the obliquity with which they strike each other, and the absence on the lingual surfaces of enamel, the edge of the teeth, like the beavers, is always kept sharp. There is a considerable diastema between the incisors and the next teeth present in the jaws, which have the appearance of molars—four maxillary and three mandibular; they are rooted teeth, are not of persistent growth, and resemble the molars of rodents. The deciduous dentition present in the animal, which differs entirely from the rodent type, proves its lemurian origin.

Simidæ are divisible into two groups: the old and new world monkeys. The latter differ in many respects from the old world monkeys, notably in their dental formula, which is $I\,\frac{2}{2}\;C\,\frac{1}{1}\;Prm\,\frac{3}{3}\;M\,\frac{3}{3}=36$. In a large number of the members of this family the anterior and posterior cusps of the molars are joined by an oblique ridge. The old world monkeys have the same dentition as man, $I\,\frac{2}{2}\;C\,\frac{1}{1}\;Prm\,\frac{2}{2}\;M\frac{3}{3}=32$, with some modifications as regards size, shape, and arrangement of roots. The anthropoid apes which approach nearest to man are the orang and gorilla. In the orang the centrals are larger, the laterals somewhat caniniform in shape, the canines stronger and much longer than any other tooth, and are less in size in the female. The first maxillary premolar is caniniform, with a large outer cusp and small inner one, a ridge of enamel uniting the two. The second premolars are three-rooted. The mandibular incisors are large and strong teeth; the first premolar has scarcely any appearance of an inner cusp; the second premolar has a well-developed inner cusp. The molars are similar to those of man. Although the gorilla has a configuration very like man the dentition differs considerably. The jaws are massive, and there is a considerable space between the maxillary incisors and canines. The first mandibular premolar is shaped like a canine, and the third molar is the largest of these teeth, differing from man. The maxillary canines in the male appear after the eruption of the third molar, and are about half as long again as any of the other teeth, being used as sexual weapons. All the Quadrumana have well-marked dentitions. Teeth of man, $I\,\frac{2}{2}\;C\,\frac{1}{1}\;Prm\,\frac{2}{2}\;M\,\frac{3}{3}=32$. Deciduous, $I\,\frac{2}{2}\;C\,\frac{1}{1}\;M\,\frac{2}{2}=20$. The maxillary central incisors are the largest; the anterior approximal surfaces are longer than the distal, making the inner angle more acute than the outer, the labial surface is concave, the lingual convex, the root is cylindrical, tapering from the neck to the apex. Lateral incisors are smaller, the distal surface is rather concave, the mesial convex, while the shape of the root is similar to that of a central. Lower central incisors are smaller than the upper, and are also smaller than the lower laterals; the distal angles are only slightly rounded off, differing from the upper; the roots are much compressed laterally; maxillary canines, labial surface convex both ways. There is a well-marked longitudinal ridge, dividing the tooth into two unequal parts; the cutting edge at the mesial part is sharp, the distal sloping gradually. The roots are large and cylindrical; the lower canine is somewhat smaller in size, and the root more compressed from side to side. Premolars: upper larger than the lower, labial surface greater than the lingual; there are two well-marked cusps separated by a transverse fissure. This tooth usually has two roots. Second premolar resembles the first, excepting the root, which is generally single. First mandibular premolar: the inner cusp is considerably smaller than the outer; its root is somewhat rounded. Second premolar: the inner cusp is larger than the outer; the outer distal side is often thickened, giving it the appearance of three cusps; the root is the same as the first premolar. Molars: maxillary somewhat square in shape, with rounded edges on the grinding surface; there are four well-marked cusps; the antero-internal is the largest, being connected by an oblique ridge with the postero-external; there are two fissures between the cusps, buccal and lingual. These teeth have three roots—palatine, anterior, and posterior buccal. Third molars vary greatly in shape and size; the roots are usually fused together; it has three cusps, two of which are buccal.

GENESIS OF THE TEETH

At about the seventh month of intra-uterine existence there is observed, on making transverse sections, in the neighbourhood of the future alveolar borders, a dipping down and proliferation of the oval epithelium. Later on little processes begin to dip down into the submucous tissue. These processes at their extremity assume a rounded appearance, increasing gradually in size and breadth; at same time the bulbous portion at its deepest part becomes concave, the inner surface of which is lined with columnar cells, from which the enamel of the future tooth originates (Fig. 1). In the submucous layer there is now noticed an uprising of this tissue, which pressing upwards moulds itself to and is surrounded by the concave surface of enamel germ. This is the dentinal germ. From the base of this dentinal germ there originates a capsule of fibrous tissue, the sacculus, which gradually surrounds the developing tooth, and eventually cuts off the neck of the enamel organ from the mass of epithelial cells. The inner layer of the sacculus at a later period forms the cementum and peridental membrane of root. Each enamel organ is thus composed of a sort of cap surmounting the dentine germ. The former is connected by a narrow epithelial band (the neck of the enamel organ) with the oral epithelium; part of this band eventually forms the enamel germ of permanent tooth. The dentine germ consists of fine connective tissue nucleated cells and blood-vessels, which anastomose freely; later on nerve fibrils are also formed. The external layer of cells and odontoblasts which form the dentine are nucleated or columnar in form, and collectively are called membrana eboris. The enamel organs of the central, lateral, canine, first and second molars, appear in succession during the seventh week of fœtal life, their respective dentine germs during the ninth week. The calcification of the central lateral incisors and canines commences at the seventeenth week of embryonic life, that of the first and second molars a week later.

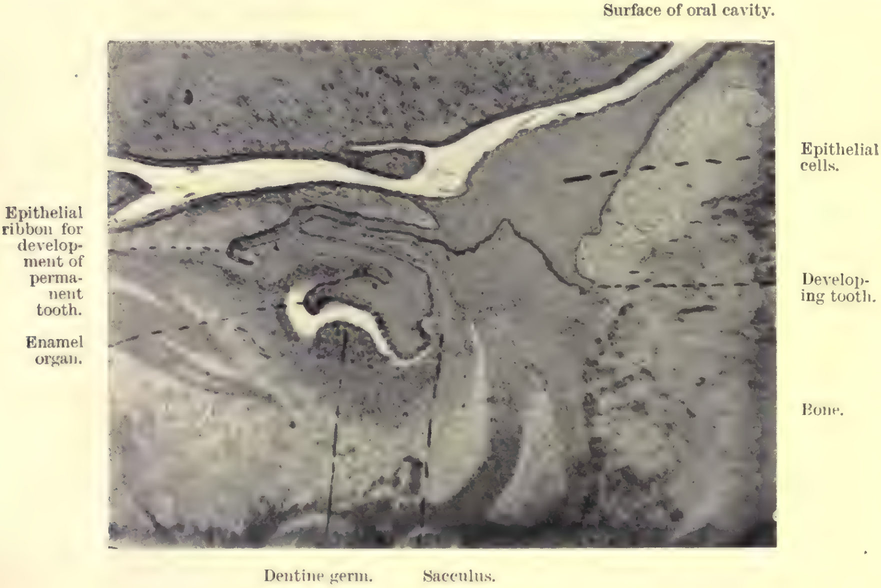


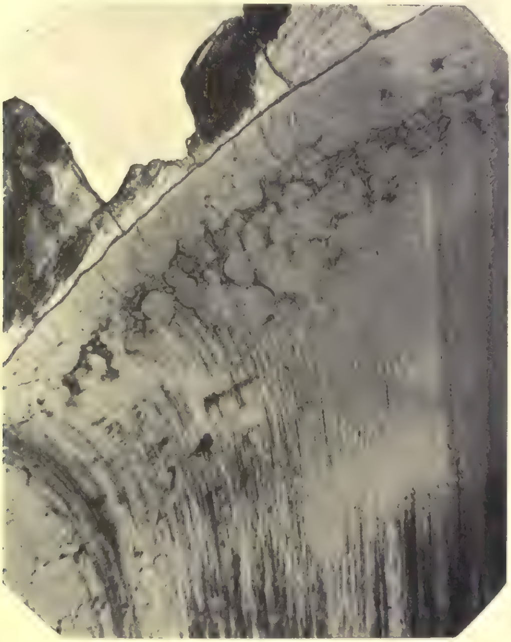
Fig. 1.

Eruption of Teeth. Primary.

7th.month	Central incisors.
7th to 10th ,, ...	Lateral incisors.
12th to 14th ,, ...	First molar
14th to 20th ,, ...	Canine.
18th to 36th ,, ...	Second molars.

At five years of age the deciduous teeth at several parts of the roots are attacked by absorption and gradually destroyed, to make way for their successors. This is brought about by the osteoclasts, multinucleated cells, which attack the root, producing irregular excavations—lacunæ of Howship.

Permanent.—Teeth of the mandible usually precede those of the maxilla by a short interval. The enamel germs of the permanent teeth are budded off from the necks of the enamel organ of corresponding primary teeth.



Faulty enamel and dentine.

FIG. 2.

The first molar has its origin from the oral epithelium, the second from the first, and the third from the second.

6½ years	First molar.
7 „	Central incisors.
8 „	Lateral incisors.
9 „	First premolar.
10 „	Second premolar.
11-12 „	Canine.
12-13 „	Second molar.
17-25 „	Third molar.

These dates are only approximately correct, as any taint—such as rachitis, struma, or syphilis—hinders the eruption of the teeth.

The greater mass of a tooth is composed of dentine, the root being coated with cementum; the crown has a cap of hard enamel, which at the neck is somewhat overlapped by the cementum. Enamel contains from 1 to 3 per cent of animal matter in the adult, but a larger proportion is present in the teeth of the young. It is composed of striated fibres or prisms running parallel with each other, and at right angles to the surface of the dentine its inner surface unites with the dentine. Enamel is the hardest tissue of the body, but does not attain its full hardness till some time after the eruption of the tooth. Defects in this tissue are fissures and a granular condition of the prisms (Fig. 2).

Dentine.—Human dentine is yellowish white, hard, and unvascular, and in structure consists of an organic matrix permeated with parallel tubes, which radiate from the pulp chamber to the periphery of the dentine, gradually decreasing in size, and giving off small intercommunicating branches as they pass outward. The size of a dental tube is $\frac{1}{4500}$ to $\frac{1}{10000}$ in. Dentine consists of 28 parts animal and 72 parts earthy matter. The walls of the tubes are composed of calco-globulin, and are very resistent to the action of acids, etc. The contents of the tubules, according to Beale Tomes, are processes of odontoblast cells, or of the cell beneath (Klein); they seem to have the property of transmitting sensation to and from the pulp. Faults in dentine are interglobular areas and contour markings which are due to faulty calcification of the tissue, or want of coalescence of the calco-spherites, leaving their contours still visible, and is a condition which favours the spread of dental caries (Fig. 2).

Cementum.—In human teeth the roots only have a thin coating of cementum, but in many animals the crown also is covered with this tissue. In newly erupted human teeth the membrane called Nasmyth's covering them is said to be composed of a thin layer of cementum. Cementum consists of a calcified, laminated basis substance, containing lacunæ and canaliculi. The lacunæ are more irregular in size, shape, and distribution than those of bone, and their canaliculi are most numerous next the peridental membrane. Sharpey's fibres, calcified bundles of fibrous tissue, are also found in the cementum. When from any cause the peridental membrane covering the root is irritated, layer after layer of cementum is deposited on the root constituting the disease called exostosis. As a rule there are no Haversian canals in cementum. The peridental membrane covering the root of a tooth is composed of a highly vascular connective tissue membrane, abundantly supplied with nerves, which are derived from the pulps, submucous tissue, and from those of contiguous alveolar wall.

DENTAL CARIES

Dental caries, so prevalent in the present day, is not by any means a disease of modern times, but evidently prevailed to a considerable extent among ancient nations, Romans, Grecians, etc. Some of the lower animals also suffer from this affection, especially domesticated animals. Curiously enough monkeys seem to be immune from dental caries, though their teeth are so much alike, both in shape and structure, to those of man. Dental caries may be defined as a gradual disintegration of the tooth substance, the lime salts being dissolved and broken up by the numerous micro-organisms which live on and assimilate the organic matrix of the tooth after the tissues are softened. The older writers considered caries to be an inflammatory process; others, that it was clearly a chemical process, etc. The first indication of caries is exhibited by the enamel, which assumes a whitish, opaque, or chalky appearance; the dentine, on the other hand, when softened becomes translucent, and frequently is pigmented of a brownish colour due to bacteria; the lighter the colour of the softened dentine the more acute and rapid the caries, the darker the carious tissue the slower it advances, and it is in such cases, on the masticating surface of a tooth for instance, where caries is sometimes arrested and the surface gets smooth and polished. Such terms as spreading, peeling, and penetrating, are applied to the different varieties of caries, but they are all the result of the structural peculiarities of the tooth when infected. Caries usually originates in some fault or fissure in the enamel, in which micro-organisms

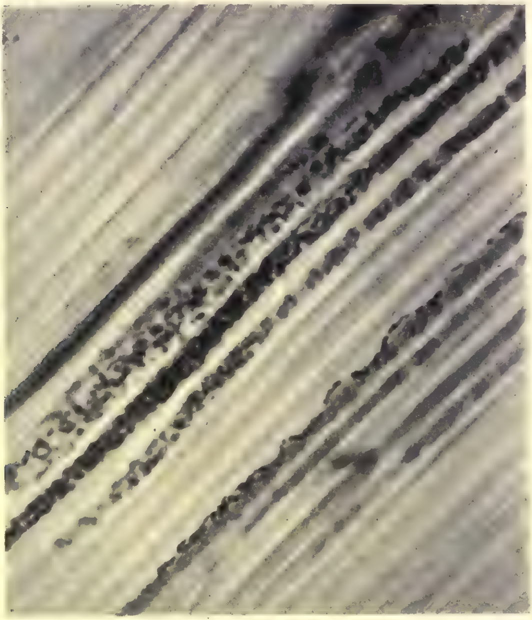

Tubules packed with organisms.
Several tubes broken down into one.
Non-infected tubules.

Fig. 3.—Section of carious dentine.

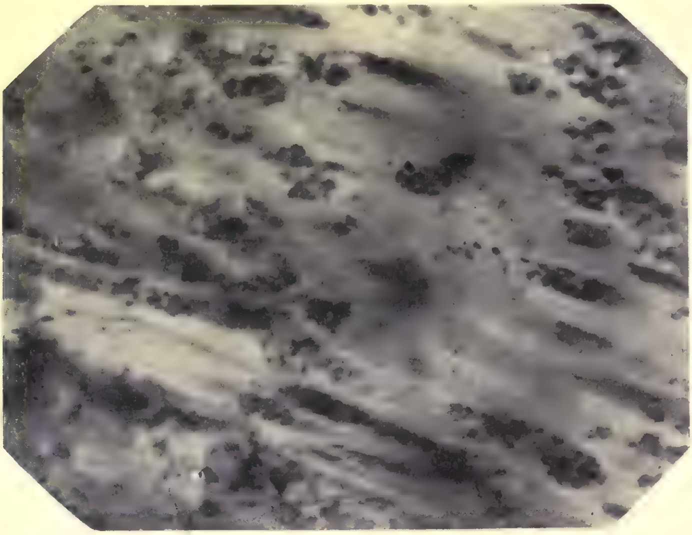


Fig. 4.—Section of carious dentine. Tubules filled with sarcinacoccus which has distended and broken them up.

find lodgment, and once the dentine is reached they rapidly penetrate the dentinal tubules, softening and breaking them up till the pulp is reached. Microscopic examination of a stained section from a carious tooth exhibit the tubules packed with micro-organisms, micrococci bacilli, or bundles of leptothrix filaments (Figs. 3, 4, 5). The latter organism is always present in all carious cavities, growing like a fringe from the walls, but less frequently penetrating and proliferating in the tubules. Sometimes uninfected tubules may be found in the midst of infected ones. Professor Miller of Berlin, in 1882, by a series of elaborate experiments, was the first to demonstrate the true pathology of dental caries, and succeeded in producing artificial dental caries in sound teeth, by subjecting them to a mixture of saliva and bread kept at a constant temperature, changing the fluid whenever it became alkaline. Other investigators, Leber and Rottenstein, Coleman Miles and Underwood, and Magitot later on, were able to show somewhat similar results.

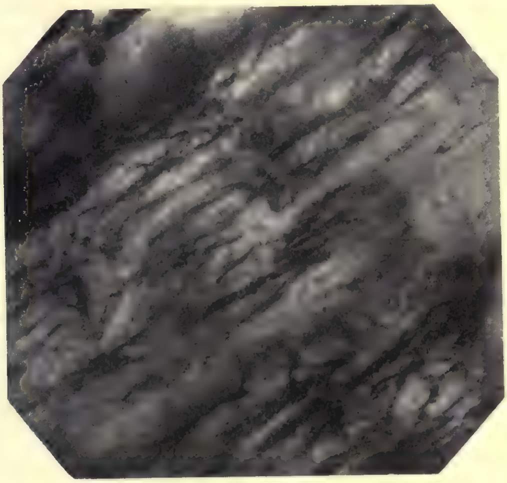


Fig. 5.—Section of carious dentine. Leptothrix fibres in tubules of dentine.

Causes of Dental Caries.—These might be divided into local and predisposing. The local are anatomical defects, interglobular spaces, fissures, accessory cusps, etc., all favour the production of caries, while a vicious arrangement of the teeth in the arches, hindering their proper cleansing, are all important factors in the predisposition to caries of the teeth. Vicintini and Leon Williams have both within recent years demonstrated and described the presence on and adherent to the teeth of gelatinous plaques of organisms called Leptothrix racemosa, which generate lactic acid, and attack any weak spot in the enamel, opening up a way for invasion of the dentine. Deficiency of lime salts in a tooth was supposed to be a potent predisposing cause in the production of caries, but from recent chemical researches by Black, confirmed by Tomes, it has been found that carious teeth frequently contain a larger proportion of lime salts than sound teeth, which seems to disprove this. This point, however, has not been proved, for, as Dr. N. Bennett says, the physical and molecular constitution require to be taken into consideration as well as the chemical ere this could be settled decisively.

Predisposing Causes.—Pregnancy, as is well known, has an injurious influence on the teeth, due to acid conditions produced by alteration of the oral secretions, as a result of dyspepsia, etc. occurring at this time. It is well recognised that acid conditions usually prevail, especially in first pregnancies, and these, aided by impaired nutrition, have a decided effect on the teeth, especially if weakened by structural defects or previous disease, and as a frequent result severe odontalgia or neuralgia is induced. The oral mucous membrane when irritated and inflamed, as it very often is in the pregnant condition, secretes acid, and this along with acid eructations have an injurious effect on the teeth. Likewise the fact that owing to the tendency to retch and be sick the teeth are often neglected at this period. It is frequently found after pregnancy that the pulps of filled teeth have become atrophied or gangrenous as a result of the impaired nutrition incident to this state, eventuating in alveolar abscess, and it may be septic local conditions. In the state of typhoid, tuberculosis, or any of the exanthemata, where vitiation of the oral secretions prevails, there exists a state of matters favourable to the development and progress of dental caries, and it is well known and expected, that after an attack of say typhoid, the teeth generally are found affected by caries, although they had given no trouble prior to this. There seems to be a greater tendency to caries between the ages of 12 and 30. Two reasons may be given why this is so: one is that the teeth of young people contain a larger amount of animal matter, making them more susceptible to attack; and, second, the teeth as a general rule are not cleansed so well as they might be, while the amount of fermentable matter in the shape of sweets, etc. taken must act injuriously on the teeth. With age the teeth get harder and less susceptible to caries.

Diet in Relation to Caries.—It has been found that diet has an important bearing in respect to dental caries, as it has been found that people living principally on farinaceous foods suffer most from caries, while flesh feeders are not so prone to it, the mastication of the tough fibrous material cleansing the teeth, and though it finds lodgment about the teeth and decomposes, the product is alkaline, whereas the soft farinaceous foods get packed in between the teeth and into fissures, fermenting and producing acid conditions favourable to the spread of caries. Dr. W. Wallace, in a paper recently read by him, attributes the prevalence of caries in the present day to the elimination from our food stuffs of the fibrous tissue, the large amount of starch food used, and the over-cooking of our animal food, giving the teeth and jaws so little to do, it being well known that organs not used are liable to degeneration. The great increase in the prevalence of dental caries in Great Britain within recent years led the British Dental Association in 1890 to appoint a committee to investigate the condition of school children's teeth, and from the valuable reports issued yearly up to date, we learn that a considerable advance has been made in the education of public opinion, and in furtherance of the supervision and treatment of school children's teeth; but much remains to be done, and it is to be hoped that ere long all board schools and others will have dental surgeons appointed to them, to look after and treat the teeth of those who are to take our places as soldiers, sailors, mechanics, merchants, etc., who will enter life poorly equipped indeed if deficient in teeth, or constantly laid up, as a result of diseases, local or general, due to septic conditions produced by numerous bad teeth. The late war has drawn attention to the numerous rejections of otherwise fit recruits, both in the army and navy, owing to defective teeth. A recruit must have ten sound teeth in either jaw to be eligible for enlistment; after enlistment not the slightest attention is paid to the teeth, which is very bad policy, and makes the primary precaution of no avail. To remedy matters, it would be well for the Government to appoint dental surgeons to the various military and naval depots, whose duty it would be to examine recruits' teeth (an expert only can tell whether a tooth is savable or not), and do the necessary operative work, inculcating on the patients at the same time the necessity of keeping their mouths in a sanitary condition by regular daily brushing of the teeth.

Condition of the Saliva in Dental Caries.—The saliva in bad cases of dental caries is frequently found thick, sticky, and of an offensive odour. In gout, rheumatism, and diabetes, the saliva is strongly acid, and as this acid is usually lactic, we can understand that this would injuriously affect weak teeth, while the presence of a large or small amount of sulphocyanide of ammonia in the saliva is said to prevent or retard dental caries. It is not definitely known whether in alkaline conditions of the saliva dental caries can progress, but it has been pointed out that some micro-organisms, which are capable of softening dentine, have alkaline products.

The opinion was held by most of the old pathologists that human saliva had poisonous properties. The writings of Habdarrhamus, Ætius, Machiafava, etc. show this. But the first authors who referred the toxic effects of mixed saliva to the influence of bacteria were Raynaud and Lannelonque, who produced septic poisoning in rabbits by inoculating them with the saliva of a child affected by hydrophobia. Pasteur, who also tried the same experiment, thought that hydrophobia had been induced, but Colin disproved this. Vulpian shortly after this demonstrated that the same condition could be produced by inoculating with healthy saliva, and other experimenters pointed out that the poisonous effects were due to the presence in the mixed saliva of micro-organisms, as sterilised saliva had little or no effect on animals experimented with.

Klein (1884) drew attention to the infectious properties of human saliva, particularly in diseased conditions of the oral cavity, showing beyond doubt that large numbers of pathogenic organisms in the shape of cocci were present in the saliva, which if taken up into the circulation in any number might produce very serious diseases. The mixed saliva of the mouth is a compound of saliva, mucus, and micro-organisms. It is generally alkaline after eating; after prolonged fasting or talking, however, it is generally acid. Wright (1844) gives some interesting information in regard to this. He says the acidity of the saliva in different diseases is due to the presence of various acids. Lactic acid is found in gout, rheumatism, intermittent fever, gastro-enteritis, and diabetes, acetic acid with aphthæ, scrofula, scorbutus, small-pox, dyspepsia, and after the use of acid wines, HCl in connection with simple gastric disturbances. Alkalinity of the saliva occurs in consequence of the presence of an excess of soda. It is considered to imply, pathologically, general or local disturbance of the nerves. The local affections of the nerves comprise facial neuralgia and odontalgia, dependent on irritation of the pulp without inflammation of the peridental membrane of the root and adjacent tissues. The alkalinity frequently is an important aid in diagnosis, inasmuch as the purely nervous facial pain is accompanied almost always by an alkaline, and the rheumatic pain by an acid saliva. It is not definitely known whether in alkaline conditions of the saliva dental caries can progress, but it has been pointed out that some micro-organisms which are capable of softening dentine have alkaline products. Attention within recent years has been drawn to the importance of a knowledge of the conditions of the salivary secretion as a method of diagnosing nutritional and diasthetic conditions of the body. At the International Medical Congress in 1901 Dr. J. C. Michaels pointed out that the salivary secretion was of more importance as a method of diagnosing diseased conditions than even urine, since the saliva holds in solution all the crystallisable substances which are the waste products of nutrition, and which, by reason of their crystalline and soluble character, are dialysable through the structure of the salivary gland. In a bad case of neurasthenia which came through my hands recently attention was drawn to the peculiar condition of the salivary secretion, which was so thick and viscid as almost to preclude the patient from spitting it out of his mouth. In cases less pronounced

than this, where the secretion is thick and stringy and exhibits an acid reaction, we always find dental caries progressing at a very rapid rate, and indicates to us the necessity of prophylactic measures being used.

Prevention of Caries.—The mouth, forming as it does an efficient incubator for the various micro-organisms, it is essential that treatment should be on antiseptic lines. All carious teeth should be treated and filled, while all roots unsavable should be removed, as they are just a source of infection to the other teeth. If the teeth in maxilla and mandible are overcrowded, it is advisable, especially in young people, to extract the four first molars, and it is wonderful how quickly the spaces fill up and relieve the overcrowding. It is requisite that an antiseptic and antacid dentifrice should be daily used with the tooth brush, especially at night, to prevent the active fermentation which would otherwise take place in an uncleansed mouth during sleep. Such a dentifrice as this might be used :—℞ Pulv. creta prac. ʒij., magnesiæ carb. ʒij., oil cinnamon 40♏, misci bene, after which the mouth might be rinsed with Philip's milk of magnesia, a valuable alkaline antiseptic. That proper cleansing of the mouth and teeth has a beneficial effect is demonstrated by the fact, that material taken from a well-brushed mouth and used to obtain a culture from, produces very few organisms compared with that from an unclean mouth. Children should be early taught to brush their teeth regularly every night, and the necessity for it explained to them, and in all cases of rapid destruction of the teeth by caries the use of Philip's milk of magnesia, the last thing at night, will greatly help to retard and control the advance of this disease.

Treatment of Caries.—In the treatment of simple caries two methods are employed. The removal of the diseased tissue, with as much of the surrounding healthy parts so as to leave a smooth and self-cleansing surface, constitutes one method. The removal of the carious tissue, and the replacement of the lost tissue by some indestructible material, the second method. Excision should only be carried out on incisor teeth very slightly affected on their approximal surfaces, the tissue being removed more especially from their lingual approximal surfaces by means of diamond discs or other appropriate instruments, and the surfaces carefully polished, and this operation should only be carried out in healthy mouths and on teeth of good quality. Perhaps no operation on the body is so successful as that of tooth filling, restoring as it does the tooth to its original size and function. Various substances are in use for filling teeth—cements, oxyphosphate of zinc, guttapercha, amalgam, tin and gold foil, porcelain fillings. Before introducing any filling material the carious tissue must be removed and the cavity shaped to retain it, sharp excavators or burs are used, and all thin and overhanging enamel edges removed. Choquet has shown that caries can progress below a tight filling, and more especially would this be the case if any softened carious tissue is left. The oxyphosphate cements are useful, being somewhat non-conducting, and adhere closely to the walls of the tooth cavity, but are more or less rapidly dissolved by the secretions of the mouth; they are very useful in lining sensitive cavities, inserting a metallic filling on the top. A recent introduction, oxyphosphate of copper, which possesses antiseptic properties, promises to be useful, especially for temporary teeth. Guttapercha is a most useful filling in cases of hypersensitive teeth, and it is the only filling that is of any avail in some such cases; the variety that lasts best in the mouth is pink in colour, and is sold for making base plates; its non-conductivity is an important factor, and it seems to get harder in the mouth after insertion, and lasts remarkably well even on masticatory surfaces.

Amalgams, which consist mainly of tin, silver, or gold in various proportions, are extensively used in filling teeth, but should only be used in posterior teeth owing to their tendency to discolour the teeth. Copper is sometimes added also, so as to get antiseptic effects. The amalgam reduced to filings is triturated in a mortar with mercury, and a stiff paste formed, which is piece by piece introduced into the dried and sterilised cavity till it is packed quite full, and it usually hardens in an hour or two. In deep cavities near the pulp it may be necessary to line with guttapercha or cement first, to prevent the conduction of changes of temperature through the metallic filling from irritating the pulp, as it has a tendency in some cases to do. A mixture of cement and amalgam filling is sometimes used for sensitive or fragile teeth. In filling teeth with whatever material it is essential that the saliva be excluded from the cavity, as it is laden with micro-organisms. A sheet of thin rubber is used largely for this purpose, a series of round holes suitable in size for the teeth it is desired to protect are punched in the material, and each one slipped over the tooth and forced close up to the neck of the tooth, tying it in place with a piece of waxed silk thread; this absolutely excludes moisture, and enables the operator to treat antiseptically or otherwise teeth requiring such treatment. Saliva ejectors, for the removal of the saliva, may be employed also, or rolls of cotton wool, etc.

Gold Filling.—This material is more usually employed than almost any other, the gold being introduced into the cavity, and welded by special instruments serrated at their points, pressure being applied by the hand, or by means of an automatic mallet or electric plugger. The gold is used in the form of cohesive or non-cohesive foil in the shape of ropes, pellets, cylinders, etc. Cohesive gold is obtained by heating to a dull red any form of pure gold, and a filling can be built up so as to replace the lost portion of a tooth. Generally two little pits are drilled at each angle on the base of the cavity, which are filled up with gold and bridged over, forming the foundation of the whole superstructure. The whole surface, on being finished and contoured, is smoothed and burnished with sand-paper discs, etc. Non-cohesive gold is used mainly in the form of cylinders, which are packed and wedged against one of the walls of the cavity, filling up till quite full, and, to obtain a harder surface, it is usual to finish up with cohesive gold. The great objection to gold and amalgam fillings are their unsightly colour, and the irritation often produced on the sensitive dental pulps by their conductivity of thermal changes, frequently resulting in acute pulpitis and suppuration, has led within recent years to the extended use of porcelain fillings, either ground to fit the cavity or, what is better, fused in a platinum or gold matrix previously burnished and fitted to the tooth cavity. The great advantages of this material are apparent: (1) its non-conductivity; (2) the ease with which the colour of the tooth can be matched; (3) the strength and resistance it possesses. The cavity must be quite open, no undercuts, all the edges smooth and sharply outlined. A piece of very thin platinum foil is laid over it, and pressed into the cavity by means of amadou, or pieces of chamois skin, and a ball-shaped burnisher, till it fits accurately. It is then carefully lifted out without disturbing it, placed in a mixture of plaster of Paris and fine asbestos. When this material is hard, the cavity in platinum is built up by degrees with a paste of the porcelain chosen, and each layer melted, as added, in Mitchell's electric or other furnace, two or three minutes for each layer being all that is necessary for low-fusing porcelains, the higher fusing not having any great advantages over the low. When the matrix is full up to the edges and glazed, the inlay can be separated from the platinum, roughened somewhat with a diamond or other disc, and inserted into the tooth with a thin creamy cement of the proper shade. A series of matching shades are given with the material, so there is no difficulty about getting the right one. The author has frequently put porcelain tips on fractured teeth, all of which have stood remarkably well, and when well made are scarcely detectable in the mouth.

Diseases of the Pulp

The pulp occupies the central portion of the crown of the tooth, and the root canal or canals, terminating at the apical foramen. It is largely endowed with nerves and blood-vessels, which terminate in loops, forming a fine plexus and network at the periphery of the organ. The pulp matrix is semi-gelatinous, and is thickly covered with cells, outer layer odontoblast, deeper layers oval, round, and connective tissue cells. Those cells, both in the bulbous and root portion, are more numerous at the periphery. In the root portion the long axis of the cells are parallel with the direction of the pulp canal. The anatomical relations of the pulp, and the fact that it is bound up in a rigid cavity, render it very susceptible to pathological conditions when irritated or inflamed. Pathological conditions of this organ might be classified thus:—

(1) Irritation of the pulp.
(2) Acute pulpitis.
(3) Chronic pulpitis.
(4) Abscess of pulp.
(5) Hypertrophy, atrophy, and degenerations of pulp.
(6) Secondary hard formations in pulp cavity.

(1) Irritation of the pulp is usually consequent on some slight injury to the enamel or subjacent dentine, either by caries, abrasion, erosion, or from fracture, or the conduction of thermal changes through a metallic filling and hypersensitive dentine. This sensitiveness to changes of temperature, it must be remembered, is one of the normal functions of the pulp. In such cases the irritation is conveyed to the pulp by means of the dentinal fibrils, as a result of which there is produced a certain amount of hyperæmia or determination of blood to the part opposite the lesion. This hyperæmia may only cause a slight distension of the blood-vessels, or result in extensive dilatation of the vessels without, however, any alteration of the tissue elements of the pulp. If the condition persists, or happens frequently, the vessels fail to contract owing to partial paralysis of their vaso-motor nerves and a permanent dilatation of their walls, results ending in exudation of their contents and the production of acute pulpitis. If, on the other hand, the irritation is removed by treatment, the pulp resumes its normal condition again. The pain caused by pulp irritation with hyperæmia is sharp, intermittent, and paroxysmal in its character, its location being commonly in the neighbourhood of the ear. The patient frequently has difficulty in locating the pain, or refers it to the wrong tooth. Pulp irritation may be, in certain cases, a resultant of pulp exposure, but in such cases the pulp speedily becomes acutely inflamed, and suppuration is likely to ensue.

Treatment.—The removal of any metallic filling, and dressing the cavity with a small piece of cotton wool soaked in carbolised resin, or equal parts of clove and cinnamon oils, retained in place with a piece of guttapercha, or cotton wool dipped in sandarach varnish. After the pulp has soothed down some non-conducting material should be inserted between the floor of the cavity and the metallic filling. Tincture of iodine applied to the gum is also useful in these cases.

Acute pulpitis.

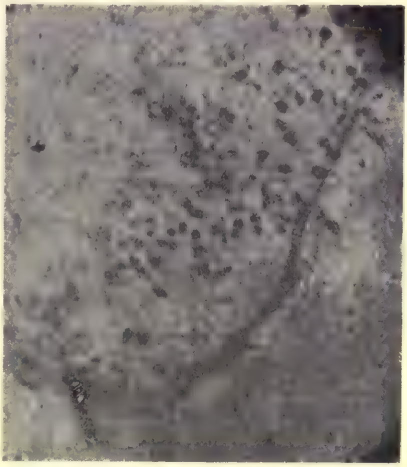


FIG. 5.

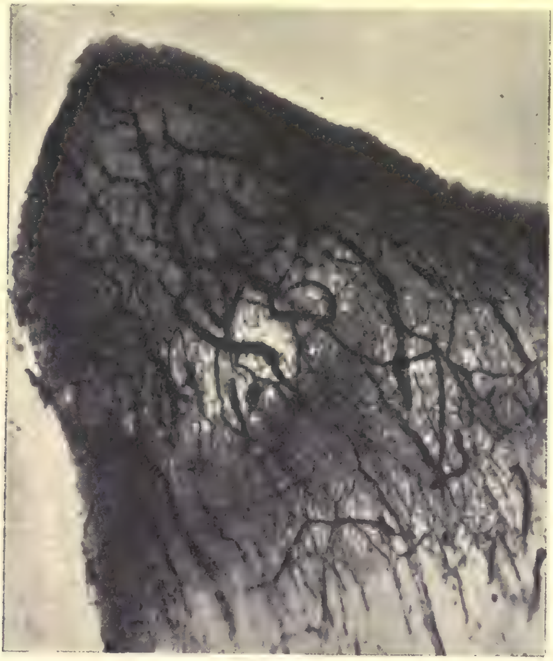


FIG. 6.

(2) Acute pulpitis is pretty common as a sequence of long-continued irritation, but is much more frequent as a result of pulp exposure from caries, fracture, etc. The inflammation may be limited in extent, or may implicate the whole of the organ (Fig. 5). In the first instance, on examination of such a pulp, it will be found in the neighbourhood of the exposure of a bright red colour shading off from the periphery to the centre, the blood-vessels are numerous and distended with blood, the nerve bundles and connective tissue cells in neighbourhood of focus of inflammation present evidences of structural changes, while a molecular cloudiness may be noticed due to the presence of numerous fat globules. As the disease extends the normal elements of the pulp become to a larger extent replaced by inflammatory exudations and fat cells, and the distended vessels, especially at apex of root or roots, are liable to be strangulated, resulting in death of the pulp. Thromboses of the main vessel

may also lead to this result. A further pathological change may be suppuration (Fig. 7), wherein the exudation cells and tissue elements of the pulp proliferate extensively and become converted into pus cells, accompanying which condition there is usually fatty degeneration. In acute pulpitis the odontoblast cells persist to the last, and are only destroyed when suppuration ensues. The symptoms of total acute pulpitis are very severe. The inflammation extends to the peridental membrane, periosteum of jaw, and the affected tooth, and adjacent ones become loose and painful to touch. There may be also a certain amount of pyrexia present. In some very acute cases the colouring matter of the blood is forced into the tubules, producing a red staining of the tooth.

Treatment.—In cases of partial acute pulpitis the anodyne dressings already mentioned and counter-irritation to the gum may allay the inflammation, and enable the tooth to be filled. A non-conducting antiseptic formagen cement or guttapercha should be used to line the cavity with, the metallic filling being placed on the outside. In cases of slight exposure of pulp a hollow cap of vulcanite containing some antiseptic paste is carefully placed over the exposure, a little cement (oxyphosphate of zinc) over this, and remainder filled with amalgam or other suitable filling. In cases of total acute pulpitis, on the other hand, especially if the pulp is much exposed and the peridental membrane affected, it is better to destroy the pulp. This is usually done with arsenious acid, the physiological action of which is to produce embolism of blood-vessels of pulp. A small portion, about the size of a pin head, of devitalising fibre (a vegetable fibre charged with As_2O_3 and creasote) is taken, and carefully inserted over the pulp, after having removed, with spoon excavators, as much as possible of the soft carious tissue from the cavity, and a piece of softened guttapercha is packed in to retain the fibre. As_2O_3, it must be remembered, is a very powerful escharotic, and must on no account touch the soft tissues of the mouth. In twenty-four hours or so the pulp will be found to be destroyed, and has to be thoroughly removed with fine barbed instruments, and the root or roots filled with guttapercha or cement, etc., under antiseptic precautions. To allay the pain incident to acute pulpitis doses of any of the following may be given:—Tincture aconite, tincture gelsemium, phenacetin, or a hypodermic injection of solution of eucaine may be useful.

(3) Chronic pulpitis, as a result of exposure, is met with more frequently than the acute form, and is very often overlooked by the patient, owing to the comparative immunity from pain associated with it (Fig. 8). Neuralgic pain in face, neck, or jaws is, however, a common association with chronic pulpitis. This form of disease is less amenable to treatment than even the acute pulpitis. The pulp at point of exposure, and for a slight depth beyond, is highly vascular and red, and from the surface is given off a serous or purulent fluid of a disagreeable phosphatic odour. Beyond the inflamed portion the pulp will be seen to be quite normal in its character. In the neighbourhood of the inflamed part the odontoblast cells are found atrophied and rapidly disappearing. As the ulcerative process extends, inflammatory degeneration is likely to ensue, and gradually reduces the pulp to a greyish yellow shrivelled mass, or, under favourable circumstances, the chronic may take on acute disease, ending in suppuration and gangrene. It is probable that the presence of micro-organisms has something to do with the ulceration on the exposed surface of pulp.

Treatment.—The pulp should be destroyed and roots filled, using antiseptic precautions.

(4) Abscess of the pulp (Fig. 7) has already been mentioned as a sequence

of acute or chronic pulpitis. Its occurrence is usually coincident with exposure of the pulp to the fluids of the mouth, which, it must be remembered, always contains pyogenic organisms. Professor Arkovy has pointed out the presence in all diseased pulps of an organism, the Bacillus gangrenæ pulpæ, which produces gangrene of this organ, and it also has a softening effect on the dentine. It may commence, as in chronic pulpitis, in a pus secreting inflammation gradually invading the deep tissues of the pulp, having a

Suppurating pulp.

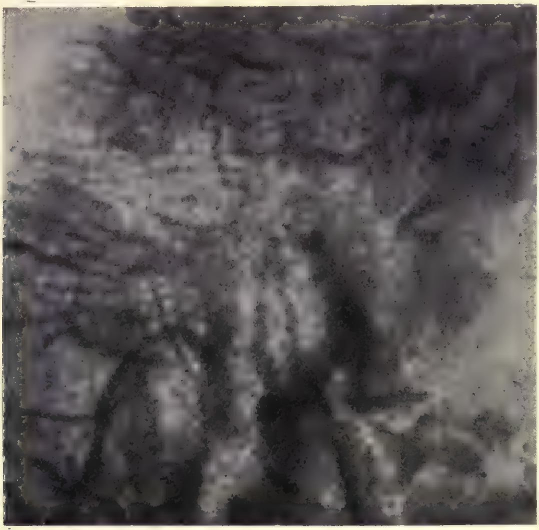


FIG. 7.

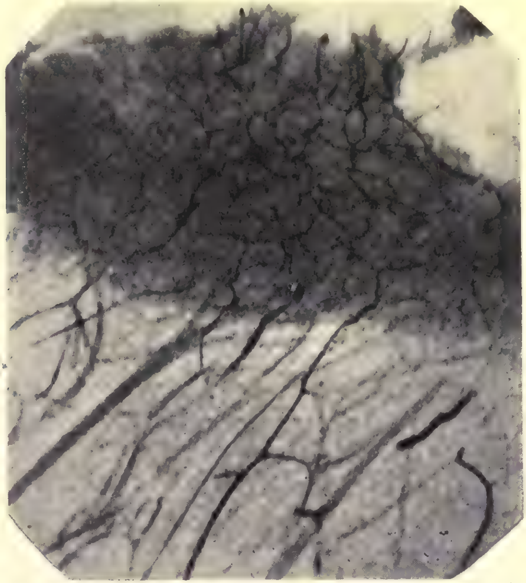


FIG. 8.—Chronic Pulpitus.

tendency to penetrate in the direction of the main blood-vessels. In the neighbourhood of the focus of suppuration the blood-vessels will be found dilated into ampullæ, the odontoblast cells are gradually undermined and destroyed, while the nerve bundles become indistinct and speedily disappear. This destructive process may go on till the whole of the pulp is destroyed, or suppuration may stop short and fatty degeneration ensue. Another rare form of abscess of the pulp is described first by Dr. A. Hugenschmidt, of Paris, who called it partial suppurating pulpitis. It frequently occurs in a seemingly sound tooth. Such pulps, according to Dr. H., have on their coronal, or root surfaces, small ulcers which secrete pus, and which travel along the external surface of the pulp, and reach the apical foramen, forming a persistent abscess over apex of root. The author has met with one such case in practice. The peculiarity of this abscess is its association with a living pulp. The amount of pain present with abscess of pulp is proportionate to the amount of exposure of that organ. If there is little or no exposure the pain produced is very severe, as it cannot expand nor shed its purulent secretion.

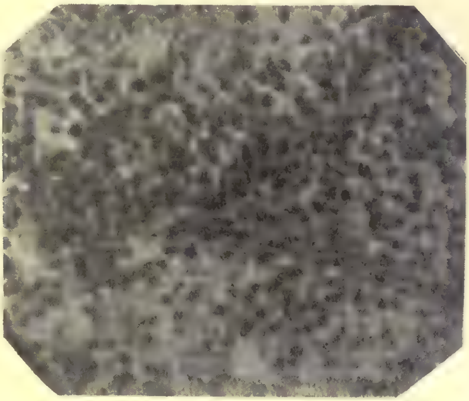

The elements of pulp converted into cells analogous to granulation cells.

FIG. 9.—Degenerative condition of pulp. Hypertrophy.

Treatment.—Destroy pulp, cleanse canals thoroughly with antiseptics, and fill root canals, inserting a filling in cavity.

(5) *Hypertrophy, Atrophy, and Degeneration of Pulp.*—Hypertrophy of the pulp, as a result of chronic pulpitis, is of common occurrence (Fig. 10). It consists of an insensitive hypertrophic growth of the pulp, which bulges through the opening into the pulp chamber, proliferating, and filling up the carious cavity with a red fleshy mass. It is supposed to be caused by the irritation of the saliva, or from micro-organisms or their products. There is an entire absence of nerves which are atrophied, the blood-vessels being enormously dilated. Such growths are composed principally of multinucleated cells, analogous to granulation cells, with a greater or less amount of interstitial fibrous tissue. Such pulps never give rise to alveolar abscess nor cause odontalgia.

Treatment.—Application of nitric acid every two or three days, and the removal of pulp, roots filled, etc.

Degeneration of the pulp as a sequence of chronic inflammation and as a result of senescence is not uncommon, and might be divided into fatty degeneration, areolation, fibroid, and calcareous degeneration (Figs. 10, 11, 12). Fatty degeneration and other changes in the pulp generally take place as the result of subacute or chronic pulpitis, and are always an indication of diminished vital activity in the organ. A pulp thus affected is reduced in volume, is somewhat opaque, and of a yellowish red or gray colour, and feels unctuous to the touch. As the process progresses the whole of the tissues of the pulp become implicated. Scattered through the

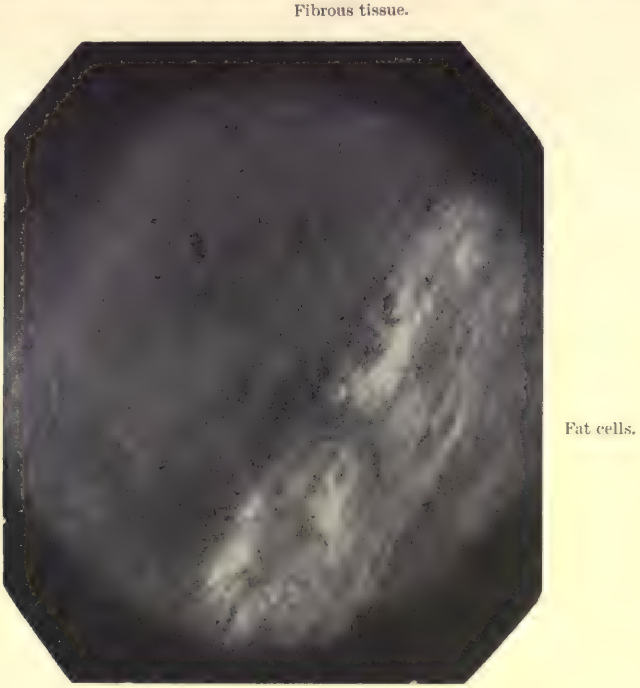


FIG. 10.—Fatty and fibroid pulp.

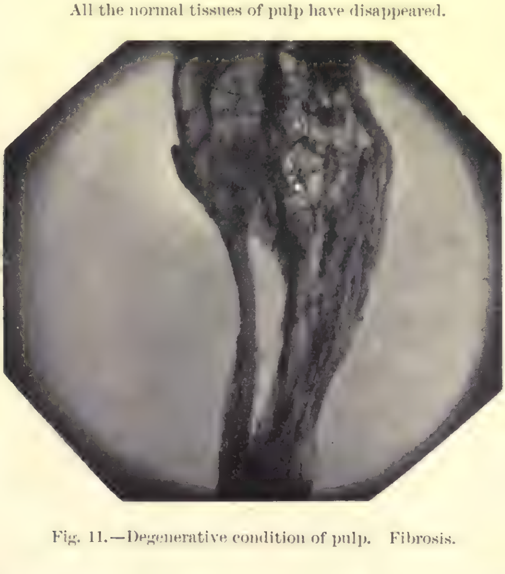


Fig. 11.—Degenerative condition of pulp. Fibrosis.

whole of the organ are numerous fat globules which obscure its ultimate structure. Such pulps do not give rise to abscess, or cause any trouble, unless exposed to the fluids of the mouth for some time. Areolation of the pulp is somewhat rare, and is a sequence of chronic pulpitis. The pulp is much reduced in size and resembles a thin membrane, is smooth in appearance, and red or brown in colour. Examined microscopically, it is found to consist of a reticulum of fine fibrous tissue, having scattered through the mesh-work of fibres numerous oval cavities. Part or whole of the pulp may be so affected. Wedl mentions another pathological condition seemingly somewhat analogous, namely sclerosis. Fibroid degeneration of the pulp, found chiefly in the worn-down teeth of elderly people, is a sequence of defective nutrition of the pulp (Fig. 11). There is an abnormal production of fibrous tissue, coarse or fine, occurring either in bundles or as a network, while the pulp cells, nerves, and blood-vessels atrophy, and if the process is unhindered the pulp shrivels up, becomes dead, or suppuration may attack and destroy it. Calcareous degeneration is very frequently associated with fibroid or fatty degenerative conditions of the pulp, and must not be confounded with calcified nodules, etc. in the pulp (Fig. 12). It consists of deposits of calcareous salts in the connective and other tissues of the pulp. The concretion is a product of inflammatory changes in the pulp, and is found in the shape of irregular, semi-transparent, oval, round, or cylindrical masses, very often adhering to the nerve trunks or surrounding the blood-vessels, forming cylinders round them (Fig. 12). They present a rugose appearance, and are dissolved in dilute acid with the evolution of CO_2 gas; their chemical composition is supposed to be phosphate and carbonate of lime. As a rule this form of calcareous concretion is found more frequently in the radical portion of the pulp than in the bulbous part. This pathological degenerative condition of the pulp is of interest, since it frequently gives rise to very severe neuralgic pain, and that often in a tooth otherwise in very good condition. Its diagnosis is difficult, and if suspected the pulp should be destroyed, roots cleared out and filled, etc.

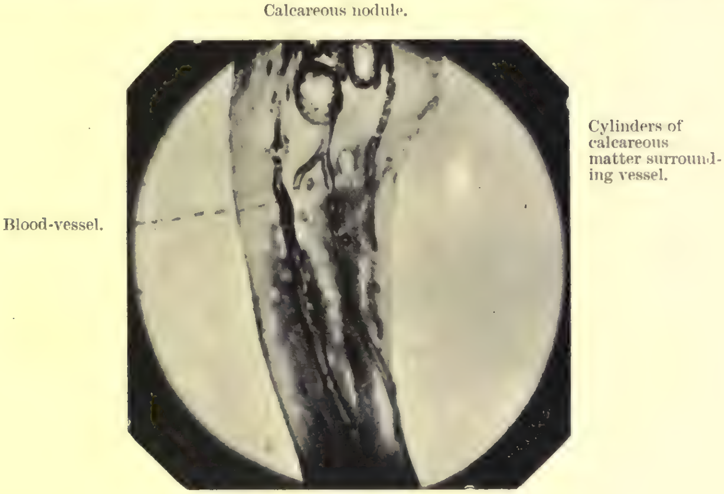


FIG. 12.—Calcareous degeneration of pulp.

(6) *Secondary Hard Formations in Pulp Cavity.*—Secondary hard formations might be divided into (i.) dentine of repair (adventitious dentine

of Hopewell Smith), a new and somewhat regular growth of dentine adherent to the pulp chamber, and deposited opposite some lesion of the tooth, such as caries, abrasion, erosion; (ii.) dentinal tumour or odontome, an irregular oval, round, or stalactitic growth of dentine growing from the pulp chamber, the tubules of primary dentine being continuous with those of the secondary growth; (iii.) osteo-dentine.

Included in this group are those irregular nodules of calcified tissue, with very small and erratic tubules, found scattered through the tissues of the pulp. In form they are flattened, round, warty, or berry-like, and present no regularity in their histological structure, but sometimes they have a laminated concentric arrangement of their tissues round a portion of the uncalcified pulp. This somewhat corresponds to the structure of osteo-dentine, though lacunæ are absent. Osteo-dentine is a variety of dentine embracing the characters of both bone and dentine, and is, like other forms of secondary dentine, developed from the connective tissue of the pulp. It is found loose in the pulp tissues in the shape of round or irregular nodules. It usually contains a blood-vessel round which is developed a concentric arrangement of the tissues analogous to that of the Haversian system in bone, agreeing with this tissue in the presence of lacunæ and canaliculi. The pulp, when the subject of inflammation, expands like other tissues, and being forced against these growths, originates severe neuralgia. Any of those varieties of secondary formation may be the cause of neuralgic pain, but the variety that more especially is productive of this condition is (ii.) dentinal tumour or odontome. As this particular variety of growth occurs frequently in seemingly sound teeth, it is very difficult of diagnosis, but a skiagraph taken of the teeth would show it up. The treatment would be to drill into the pulp, destroy and remove it, etc.

DISEASES OF PERIDENTAL MEMBRANE

The peridental membrane covers the root of the tooth, and acts as a kind of cushion to the teeth when subjected to blows or roughly used in mastication. It is composed of fibrous tissue, is very vascular (the blood-vessels also supply the cementum with nutrition), and is richly supplied with nerves which are the source of the sense of touch in the teeth, and are the origin of the severe pain incident to conditions of inflammation of this organ.

Etiology.—The causes are various. General causes are gout, syphilis, rheumatism, struma, mercurialism. Local: blows, filling tooth too full, accumulations of tartar, phosphorous poisoning, putrid pulp, filling tooth before canals are aseptic. Strumous periodontitis is accompanied by less pain than that of the ordinary form of peridental inflammation, and suppuration speedily ensues. Rheumatic periodontitis, though rather painful, is of that kind termed plastic periodontitis, and does not tend to suppuration. Peridental disease may be divided into (*a*) acute; (*b*) chronic.

(*a*) *Acute Periodontitis.—Symptoms.*—Sensitiveness of root involved, characterised as a dull sensation of oppression in the tooth. After this has continued for some hours or days uninterrupted pain occurs in the tooth, and is intensified when the tooth is touched or used. Pain is also increased by warmth, active movement, the horizontal position, or stimulating drinks. The gum over the root of the tooth now becomes swollen, red, hot to the touch, sensitive to pressure, especially at apex of root, and the tooth feels raised in its socket. With some patients there is a general indisposition, furred tongue, and more or less pyrexia. The pain now becomes more severe, and the inflammation affects the tooth on either side, spreads to the gums and face, producing œdema. With the latter symptoms suppuration occurs, the pain becomes less acute, and assumes a more dull and pulsating character. Over the apex of root may now be observed a swelling which, on attaining its full size, becomes soft and fluctuating; the pus eventually forces its way through. As soon as the pus is evacuated there is a rapid diminution of all the symptoms, and the tooth after a time resumes its former position and firmness, or a chronic alveolar abscess may be formed. Average duration of acute periodontitis, seven or eight days. There are, of course, subacute forms of this disease also, which are more amenable to remedial treatment.

Treatment.—In the acute form palliative treatment only can be used at first. The application to the gum of ℞ Tinct. iodine (lin.) ʒij., acid carbolic ʒj., or capsicum plasters, freely incising the gum. Hypodermic injection into the gum of sol. eucaine, or the internal administration of 8 grs. phenacetin every three hours; free purging. After the acute symptoms have disappeared thorough asepsis of root canal must be carried out, and the root and tooth filled. The diagnosis between acute pulpitis and acute periodontitis is not difficult. On tapping a tooth affected by acute pulpitis there will be little or no pain compared to that of the tooth with the inflamed peridental membrane. In the case of a front tooth there will also be some discoloration due to staining of the dentine by the decomposing pulp.

(*b*) *Chronic Periodontitis.—Symptoms.*—These are very much less severe; in fact, at first they are of such an ill-defined nature that they easily escape the notice of less observant patients, until in course of time severe pain is felt at the apex of the root, intermitting, however, and the tooth elongates, or the gum becomes inflamed, and a yellowish mucous or purulent fluid of an offensive odour oozes out from between the gum and tooth on pressure being applied. Time after time the same thing happens, and the tooth is eventually lost from alveolar abscess. The process continues throughout a local one, and the general system is not disturbed. In chronic inflammation the peridental membrane gets very much thickened, and is often affected by degenerative conditions, fatty, calcareous, etc.

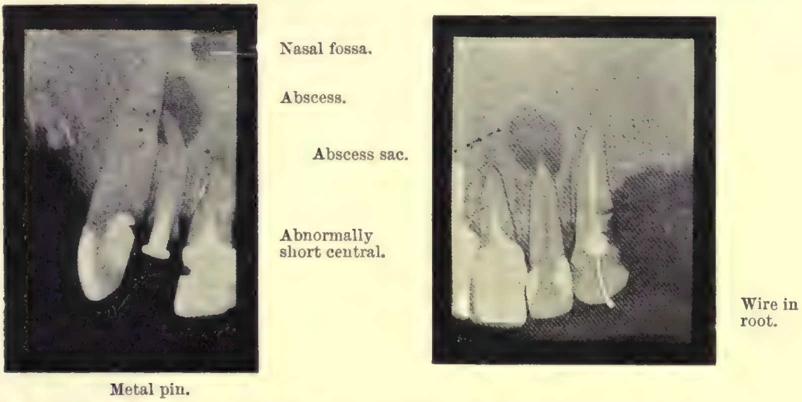
In teeth the subjects of chronic periodontitis there is liable to be produced exostosis, or absorption and redeposition may take place alternately.

General Periodontitis.—Several teeth may be affected by periodontitis, the inflammation spreading to periosteum of jaw and gums. This form occurs frequently as a result of typhoid, syphilis, necrosis, or the administration of Hg. or phosphorus. The symptoms are the same as those of the local form, and the treatment depends on the origin. To prevent suppuration free incisions of the gum are necessary, and the application of an astringent, such as tannin or phenate of soda, as mouth-washes are useful. The majority of these cases are a result of septic conditions of the canals of tooth, which, therefore, should be attended to, and the gum also treated. Massage is useful. When the tooth is much elongated a portion of it or its opponent should be cut down. Dr. Kirk has recently drawn attention to cases of what he calls intra-peridental abscesses occurring in teeth with live pulps.

ALVEOLAR ABSCESS

Periodontitis in connection with carious teeth leading to alveolar abscess is common to both jaws, or there may be developed an abscess in the substance of the maxilla or mandible. The symptoms of alveolar abscess are very similar to those of acute periodontitis—the tooth is loose, the pain severe, and of a dull throbbing character, the intensity of the pain at this stage being proportionate to the penetrability or impenetrability of the surrounding bone, which is removed by absorption produced by the abscess sac and its contents. The disease commences at the apex of the root of a carious pulpless tooth by the effusion of plastic material from the inflamed peridental membrane, which forms a sac at the extremity of the root, pus being formed in the interior. As the sac increases in size the surrounding osseous tissue is removed by absorption, and in some cases a considerable portion of the root may be destroyed by the same process.

Acute Alveolar Abscess.—The symptoms are very severe, and the consequent œdema more intense, the neighbouring teeth and alveolar periosteum being also affected by the extension of the inflammation. There are frequently febrile symptoms, quickened pulse, furred tongue, and general indisposition. As soon as pus forms rapid absorption of the surrounding bone takes place, and the pus finds an exit, either through the alveolus over the apex of the root, or it oozes out from between the gum and socket of the tooth. After evacuation of the pus the symptoms decrease rapidly, and the tooth regains its former state or assumes the chronic condition. The sac is sometimes brought away with the tooth on extraction. The sac of acute abscess is thin and smooth, in contradistinction to that of the chronic, which is very thick and rough, and sometimes contains calcareous matter or bony spicules. The extremity of the root in such teeth is sometimes surrounded by a deposit of tartar derived from the exuded blood or serum.



Skiagraphs illustrating abscess formation in relation to teeth and proximity to nasal fossa.

Chronic Alveolar Abscess.—The symptoms are slight and local. There is generally a discharge of pus, more or less constant, through a sinus at or near the apex of root of abscessed tooth. Pus from an alveolar abscess may travel a great distance from its source, always taking the easiest route. The usual position for the pus to make an exit is through the external alveolar plate near apex of root. Alveolar abscess in connection with upper incisors has been known to point in the nostril. Tomes and others have drawn attention to this peculiarity of the maxillary lateral incisor, the pus from which has a tendency to burrow beneath the periosteum and bone of hard palate, and opening on the soft palate, forcing the soft tissues down to the level of the teeth. But pus may find its way on to the face, beneath the chin, or into the antrum. In the case of the third molars pus frequently passes between the muscles and the bone, and escapes at the angle of the mandible, the nape of the neck, or even on the thorax. There are also cases of chronic abscess without a sinus, which are much more difficult of treatment. Abscess of teeth in the mandible, as in the maxilla, more frequently points through the external alveolar wall than through the lingual. An abscess sometimes forms in the substance of the maxilla or mandible as a consequence of the presence of diseased teeth, but differs from ordinary alveolar abscess in that it does not discharge through the tooth-socket, but causes considerable expansion of the bone and consequent disfigurement, especially in the mandible. In the maxilla it has been mistaken for antrum disease. Sequelæ of alveolar abscess: sub-periosteal effusion, producing necrosis of bone; suppuration of adjacent lymphatic glands; pyæmia, œdema, and spasm of glottis; cellulitis; post-pharyngeal abscess; paralysis of facial muscles; trismus; paralysis of arm.[1]

Treatment.—Acute.—In cases where pus is oozing from between the gum and socket of the tooth it is better to remove it at once. If the tooth is savable palliative remedies should be applied, the pus evacuated by free incisions, tinct. iodine lin. applied to gum, or by electrical cataphoresis, capsicum plasters, etc.; half gr. pill. calci sulph. every three hours, useful to cause absorption of inflammatory exudate. After acute symptoms have disappeared the canals should be made aseptic and filled, also tooth cavity. In chronic alveolar abscess the root canals should be cleansed, and H_2O_2 forced through the tooth and sinus by means of an abscess-syringe, etc., finishing up with pure carbolic acid, tincture of iodine, or alcoholic solution of hydronapthol, the tooth temporarily dressed, and this treatment repeated every three or four days till all tenderness over root has disappeared. Immediate root-filling is practised by some, but cannot be depended on. In teeth with no sinus repeated cleansing of the root usually results in the abscess healing up, but it is necessary in some cases to drill a hole over apex of tooth, so that some antiseptic may be forced through, or the abscess-sac destroyed and the root and tooth filled. In cases of abscess in the substance of the bone, the tooth causing the condition should be removed, and the abscess cavity scraped and packed with boric lint till healing take place. Excision of the whole or apical portion of the root of an abscessed tooth is sometimes practised for the cure of chronic alveolar abscess.

Exostosis

The cementum which forms the outer layer of root of tooth is very liable to hypertrophy, which is induced by chronic irritation of the peridental membrane. Normally, the amount of this tissue on healthy teeth varies greatly, so much so, that it is difficult in slight cases of exostosis to diagnose between normal and abnormal conditions. The usual form of exostosis consists of an excess of the normal tissue, layer after layer of the tissue being deposited on part or whole of the root (Fig. 13). It is usually non-vascular, but sometimes blood-vessels penetrate into it, the tissue forming a kind of Haversian system round it. Any part of the root may be affected by exostosis, but its usual situation is on the lower third of root of the tooth. The varieties are—(1) a globular, encircling the extremity of the root; (2) an irregular mass encircling extremity of root or roots, or whole of the root; (3) an even incrustation of whole root, becoming attenuated towards the neck of tooth; (4) as small isolated nodules very hard and attached to the side or near the extremity of root. When from alveolar abscess the whole or a portion of the peridental membrane is destroyed, no development of cementum can take place, which accounts for those cases where the exostosis recurs on one side of root only or in patches. In well-marked cases of the disease distinct laminations are observed, lacunæ and canaliculæ being scattered through them, intercommunicating with each other (Fig. 15). Two or three teeth or roots are occasionally found united together by cementum.

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[1] Article "Teeth," by G. W. Watson, L.D.S.

Symptoms.—When the disease has its origin in a tooth also affected by caries, it is extremely difficult to diagnose, owing to the similarity of the symptoms to other pathological conditions, such as chronic pulpitis, etc., and this is much more the case when the crown of the tooth is free from any lesion. Neuralgic pain in face, head, or neck may be, and often is, the only indication of disease, making it very difficult to diagnose which tooth is at fault; and it is only after prolonged suffering that a diagnosis can be made, the tooth becoming painful on tapping, or to thermal changes.

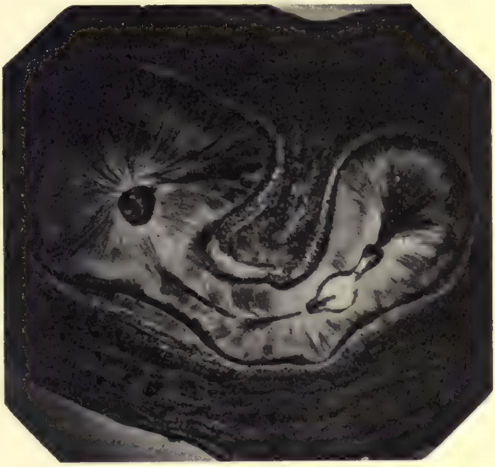


FIG. 13.—T. section of $M\frac{0}{3}$ affected by exostosis.

A ready method of diagnosing exostosis can be effected by taking a skiagram of the teeth on the side affected. In some cases tooth after tooth has to be sacrificed on account of this disease. The variety of exostosis which is productive of the most agonising pain is the isolated nodule, which fortunately is somewhat rarer than most of the other forms. The severe pain incident to this condition is produced by the pressure of those irregular growths on the irritated nerves of the peridental membrane.

Treatment.—Extraction.

PYORRHŒA ALVEOLARIS

Pyorrhœa is a disease which has been prevalent among mankind and also some of our domesticated pets from the earliest times. The local conditions to which the name pyorrhœa has been applied consists in a deeply congested condition of the mucous membrane round the necks of the affected teeth, to which it is non-adherent, accompanied by a thick, fœtid, purulent, or sanious discharge, laden with micro-organisms, exuding down between the gum and the tooth on pressure being applied, and which communicates a most offensive odour to the breath. After a time the alveoli become absorbed, and the peridental membrane of the root is gradually destroyed, accompanied by loosening of the tooth, exposure of part of the root, and a deposit thereon of salivary calculus of a greenish brown colour, though this is not invariably the case. In some conditions of this disease there is no recession of the gum, and little or no tartar present. One tooth only, or several, may be attacked at a time, and the front teeth are more prone to this disease than the posterior. The disease may be acute or chronic, and generally occurs in patients of middle age, and who are in a debilitated condition, suffering from some chronic disorder, such as gout, syphilis, Bright's disease, anæmia, tuberculosis, etc. Or the cause may be local, such as oral uncleanliness, the presence of tartar, or badly adapted artificial plates or crowns. The disease in its earlier stages is quite curable, but if allowed to progress till the tooth socket has been destroyed little good can be done. The extraction of affected teeth stops short the disease, and it is of interest to note that the destruction of the pulp likewise has this effect. Medical opinion in recent years, in reference to pyorrhœa, seems to bear out the idea that this disease is a frequent source, when neglected, of various diseased conditions in the lungs, bronchial tubes, pharynx, pericardium, etc. (Spencer, Savill, Ewart, Godlee, etc.). There is no doubt that very septic conditions frequently prevail in pyorrhœa cases, making it a source of danger.

There are differences of opinion as to whether the disease is due to local or constitutional causes.

Treatment.—The Americans, attributing this disease largely to the presence in the blood of uric acid, treat it accordingly, but there is no warrant for this belief, or that it should be produced by this diathesis, more than that of any of the other conditions predisposing to it already mentioned. Local treatment consists of syringing out the gum sockets with 3 per cent H_2O_2 or pyrozone, then follow up with a drop or two of pure carbolic acid, or with a flattened piece of wood pack the pockets with powdered sulphate of copper. The latter treatment should be repeated every four or five days, and generally in a few weeks results in a marked improvement of the symptoms. All loose teeth should be removed, and also any tartar covering the root, special instruments having to be used for this purpose. Another very valuable adjunct in the treatment of this troublesome disease is electricity applied by means of zinc or copper electrodes applied to the gum pockets in the presence of dilute acid, the beneficial effect of the acid salts so generated being obtained on the diseased tissues.

Irregularity in Number, Size, and Position of the Teeth. Deficiency of Teeth.—The tooth, perhaps, most frequently absent from the series is the maxillary lateral incisor; one or both may be absent, and is very often an hereditary peculiarity. Absence of teeth, however, does not always mean their entire suppression, as they frequently are deeply buried in the substance of the jaw, and only turn up after all the other teeth are lost. The most of the so-called cases of third dentitions are just analogous cases. The author has models of two cases where in edentulous subjects, one aged eighty-six, the other seventy-eight, two canines appeared. Cases have been recorded of the entire absence of both temporary and permanent dentitions, or of the presence of only a few teeth in either jaw. Supernumerary teeth might be divided into—(1) teeth resembling the normal members of the series—centrals, laterals, canines, and bicuspids; (2) conical teeth, having no peculiar characteristics. The first are sometimes called supplemental teeth, and are found generally in the front of the mouth, either in line with the other teeth outside the arch, or on the palatine side of incisors. In the mandible they are placed on the lingual side of the incisors. These supplemental incisors are thought to be just a reversion to the typical number. Extra canines, and three bicuspids on either side, are fairly common; an extra molar on either side has also been observed. Supernumerary teeth are conical in shape, with a short single root. They are usually found present in the incisor region, between or at the back of them, and sometimes in association with the third molar, especially in the maxilla.

Treatment.—If ranged alongside of the other teeth, and the patient is over twenty years of age, it is better to retain them; if, on the other hand, the patient is young, it is better to extract. Teeth situated on the palate, or outside of the arch, interfering with the tongue or bite, are better removed. Teeth excessive in size, amounting almost to deformity, are met with sometimes, and are frequently an association of hyperostosis.

Irregularities in the position of individual teeth, and abnormalities of the maxilla and mandible, are very common in the present day, and seem to be to a certain extent more prevalent among civilised than among savage races. A great many causes are adduced to account for it; the disuse of one's jaws and teeth, owing to the prevalence of cooking, the early loss or extraction of the primary teeth, or too long retention of them, all influencing more or less vicious arrangements of these organs; while malformations of the maxilla and mandible may be caused by thumb or tongue sucking, mouth breathing, the presence of adenoids, etc., or may be congenital.

In treating cases of irregularity, it is important to know which teeth to extract and which to retain, so as to make room in the arches. As a general rule with young patients, say from ten to fourteen, the first molars, especially if carious, should be extracted, this being a tooth that almost invariably, sooner or later, is attacked by this disease. In patients from fourteen to eighteen years of age it is better practice to extract the first bicuspid, as the teeth will be more readily and quickly acted on by regulating apparatus. In the case of the incisors, it may be necessary sometimes to extract the laterals; but of course both ought to be removed, as it would make the arch unsymmetrical if only one were extracted. The prominent canine teeth should always be retained, as they are characteristic feature teeth, unless they lie in such a position as to make it impossible to get them into place in the arch. The temporary canines should also be retained as long as possible, because their successors do not erupt till after the tooth on either side is in place, and are liable to be crowded out if the space is not kept.

Another important matter is, not to commence at too early an age to treat mechanically such conditions, and also to remember that, provided there is room, the lips and tongue, aided by some help from an intelligent patient, work wonders in bringing into place teeth very badly misplaced.

A good method of finding out, before treatment, what room will be obtained in the arch, and how the teeth will look, is shown by taking models of both jaws, cutting off from plaster cast the teeth proposed to be extracted, also all the irregular teeth, and refixing them with wax in their normal positions, so as to articulate with the bite. This enables you at once to see how they will look, and what room you have to come and go upon.

Irregularities of the Separate Teeth.—Maxillary central incisors may bite inside, instead of outside, of the mandibular teeth. A vulcanite plate covering the molars, so as to raise the bite, and compressed hickory wedges, or piano wire springs fixed at the back of the misplaced teeth, will speedily remedy this defect. Protrusion of these teeth is common, and necessitates the extraction of a tooth on either side, and the application of pressure from the front by means of elastic bands, or what is better, piano or gold wire, adapted to the outer surfaces of the teeth, and attached to metal bands round the posterior teeth, and capable of being tightened. The two teeth are sometimes overlapped, or are arranged at right angles to each other, in which case the operation of torsion may be employed. Forceps are carefully padded, and the tooth or teeth are carefully twisted into position, being retained there with a splint till fixed.

Lateral Incisors.—Irregularities in these teeth are common outside or inside of bite, or twisted on their axes to various degrees. Some operators practise alveolotomy in bad cases of irregularity, which consists in making incisions with a saw through the alveolus on either side of the tooth to be moved, and forcing the tooth with suitable forceps into its proper position, retaining it there with a plate.

Canines frequently erupt considerably outside of the arch, both generally being affected, and there may be no room for them in the arch. To remedy this in young patients the first molars should be extracted, and the bicuspids retracted by means of a spring plate, etc. The extraction of the first bicuspid in older patients produces more certain and more rapid results. Canines sometimes erupt on the palate, in which case extraction is the only remedy. Bicuspids or molars, if crowded out of the arch, are better removed. The third molar assumes various irregular positions; its crown may be projected against the root of the second molar, and cause caries or absorption of it, or it may incline backwards, outwards, or inwards.

Abnormalities of the Jaws and Teeth. 1. V-*shaped Maxilla.*—In this deformity the arch is very much narrowed by the approximation of the bicuspids towards the middle line. In some cases the two centrals meet at an acute angle and project very much. The condition is frequently an hereditary one, though in some cases the presence of adenoids or enlarged tonsils may aid indirectly in producing this deformity. Some authorities have also asserted that congenital idiocy is frequently associated with it.

Treatment.—If an inherited condition, treatment is often very unsatisfactory, as the teeth have a tendency to return to their original positions. The usual method is to make a split vulcanite plate, on which is fixed a jack-screw capable of being tightened up, and acting on the alveolus and teeth on either side in the neighbourhood of the bicuspids. Or a split plate with piano wire spring may be employed.

Underhung Bite.—In this irregularity the four or six front teeth of the maxilla bite at the back of those of the mandible, giving the mandible a very prominent appearance. To correct this irregularity the bite is raised by capping the posterior teeth, and the teeth affected are forced outwards gradually by means of screws, piano wire springs, or hickory wedges, till they overlap the lower teeth, when the plate can be removed.

Open Bite.—This is a very disfiguring deformity, in which the upper and lower teeth are separated from one another by a wide space, the only teeth touching being the bicuspids or molars. A large number of those cases are due to thumb or finger sucking, which is sometimes continued well into adult life. The alveolar process of maxilla and teeth are gradually forced upwards and outwards by the persistent pressure, and the mandibular teeth are forced downwards and outwards from the same cause. Other causes are tongue-sucking, the persistent use of artificial teats, arrest in development of the anterior segments of the maxilla, or defective development of the ascending ramus of the mandible.

Treatment consists in grinding down the antagonising teeth so as to allow the jaws to approximate, or the extraction of the first molar teeth, and the use of a chin and skull cap for six or eight months may lead to some improvement.

DENTAL NECROSIS

A pulpless tooth still has a certain amount of vitality through the nerves and blood-vessels of peridental membrane which supply the cementum and probably a layer of the dentum also. Partial necrosis is the proper term to apply to such a tooth. When the peridental membrane as well as the pulp is destroyed (complete necrosis), the tooth becomes loose, and is speedily cast out as a foreign body. Partially necrosed teeth last wonderfully well, but are more prone to caries owing to the loss of vitality. One root of a multiple-rooted tooth may become necrosed, and is liable to be very troublesome. Heat and cold affect it, likewise pressure, the cause of the latter being the irritation produced on the soft tissues at root apex by the roughness or sharpness of root caused by absorption. Discoloration of necrosed teeth is common. A pinkish or dark-grey hue is commonly produced. Necrosed teeth sometimes cause severe inflammation and necrosis of a portion of alveolus.

Treatment.—In partial necrosis of a multi-rooted tooth, amputation of affected root recommended, or extraction of tooth. When the crown of any of the anterior teeth is discoloured as a result of caries and partial necrosis, it is advisable to bleach it. The carious tissue is removed, the pulp canal antiseptically treated and filled. The cavity should then be wiped out with absolute alcohol and hot air applied, then washed out with dilute ammonia, dried with hot air, and a piece of cotton-wool saturated with H_2O_2 or pyrozone inserted, and hot air applied to this. This treatment, applied every three days or so, three or four times, has a wonderful effect in restoring the colour of badly discoloured teeth. Electric cataphoresis with pyrozone is, however, more speedy in its action than the above. In cases of total necrosis it is better to remove the tooth at once.

ABRASION AND EROSION

In certain conditions of the bite, notably that of edge to edge, the teeth get rapidly worn down till near the gum margin, leaving a smooth and polished surface. As the process advances the pulp is encroached upon, and frequently the teeth get very painful, though more commonly the pulp calcifies in advance of the wear. In countries where little pains are taken in preparing their flour, which consequently contains sand, the teeth are rapidly worn down from this cause till there is nothing left but roots.

Erosion may be described as a gradual destruction of the labial portion of a tooth, occurring as a transverse, smooth, open groove at the neck of the tooth, more especially of the incisors, canines, and premolars, and gradually progressing till the tooth is broken across. Erosion is a condition little understood, though recognised by some of the old writers—Fox, Hunter, etc.—many years ago. Various theories have been adduced to account for it. It has been attributed to friction of the lips, excessive use of tooth-brush and powders, gout, acids, etc. From microscopic investigation, Mr. Underwood has found that teeth affected by erosion are structurally defective, more especially the enamel, and all authors agree that the oral secretion in all such cases is strongly acid. Drs. Kirk and Buchard were the first to suggest that the irritated labial follicles in the mucous membrane opposite the affected teeth might be the cause of the erosion. Mr. Royston, in a paper on Erosion published recently, gives a valuable hint in reference to the treatment of such cases, suggesting that not only the tooth, but also the mucous glands in neighbourhood of teeth affected, should be touched with $AgNO_3$, he having found great benefit resulting therefrom.

Treatment.—Abrasion.—When the teeth are much worn down, caps of gold or porcelain tips are fitted to the teeth. When there is tenderness of tooth the application of $AgNO_3$ is useful. Erosion.—$AgNO_3$ applied to surface of teeth affected, and also to mucous glands contiguous to teeth; also the daily use of Philip's milk of magnesia as a mouth wash will be found of great service.

ELECTRO-CATAPHORESIS

Within recent years cataphoresis has been extensively used for various dental operations. It may be described as electrical diffusion of fluids through the soft and hard tissues, a kind of electric osmosis. A series of dry-cell batteries, capable of producing a current up to about 40 volts or so, are used, and an instrument, rheostat, or volt selector, also a milliampèremeter, to record the quantity administered. Various electrodes adapted for the different purposes are used. In the destruction of a tooth pulp the positive electrode is applied to the tooth, the negative—attached to a wet sponge—held in the hand; a piece of cotton-wool saturated with a 20 per cent solution of cocaine hydrochlorate in guaiacol, or meditrina, is inserted into the cavity of the tooth, and the current gradually turned on. One-twentieth of 1 milliampère to 3 or 4 milliampères is all that is required for dental operations, but the time taken is rather a serious consideration, seven minutes to fifty or sixty minutes being commonly required to get the requisite results. Sensitive dentine can be obtunded by this means, and the pain of acute periodontitis allayed by it, while discoloured teeth are readily bleached by the aid of a 20 per cent solution of hydrogen peroxide. For tooth extraction it is not so successful.

ORAL SEPSIS AND GENERAL BACTERIOLOGY OF MOUTH

As is well known, the oral cavity forms a very suitable incubator for the various micro-organisms. The number of organisms present in any mouth is proportionate to the cleanliness with which it is kept, and the condition of health or disease of the contained organs. When teeth are defective in number and the mouth full of diseased and putrid roots, there will be also present, as a result of such conditions, numberless pathogenic and non-pathogenic bacteria, and, as a sequence of such an insanitary state of the oral cavity, the patient is likely to suffer from some of the following: dyspepsia, anæmia, headache, constipation, etc.

About 1882-84 Professor Miller of Berlin began publishing a series of papers in reference to the organisms of the mouth and their connection with disease, which greatly extended our knowledge of the important bearing micro-organisms have in the production of various diseased conditions in the oral cavity and at a distance. The human mouth is well adapted for the development of bacteria; the constant temperature and the presence in the mouth of food débris, dead tissues, etc., all conduce to the nutrition and rapid proliferation of micro-organisms. Almost every known variety has been found in the human mouth, and in certain diseased conditions, such as that of typhoid, there may be present animal organisms also. Virulent pathogenic bacteria are frequently found even in healthy mouths. The danger of infection from the presence of such pathogenic organisms is proportional to the dosage, the condition of the mucous membrane, and the immunity or non-immunity of the individual when subjected to infection. In the dirty and diseased mouth are found at the margins of the gums, on and between the teeth, masses of micro-organisms, streptococci, staphylococci, bacilli spirillum sputugenum, spirochœta dentum, yeast cells, etc. (Fig. 14). The removal of septic roots and proper cleansing of the mouth have a wonderful effect in reducing the number of microbes, especially the coma and spirillum forms, which are always present in large numbers in diseased and filthy conditions of the oral cavity.

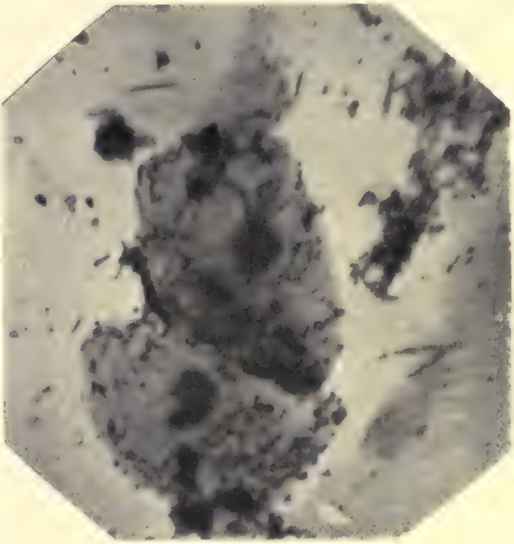


Fig. 14.—Two epithelial scales from mouth covered with micro-organisms.

Of twenty-two microbes isolated by Dr. Miller, ten were in the form of cocci of various sizes, five appeared as short, and six as long staffs. One species formed spirillum, another developed long threads. Of thirty varieties cultivated subsequently eighteen were cocci, eleven staffs, one formed threads in fluids, three developed long connected or unconnected threads, one produced spirillum, eight were motile, fourteen immotile, only three showed spore formation, the others seemingly propagating themselves by fusion. They exhibited great differences in their relation to oxygen ; ten were found aerobic ; four grew best in air, but could also do without ; eight proved to be chromogenic, producing yellow masses in nutrient jelly. Dr. Miller also pointed out that the pigmentation of the dentine in dental caries was due to pigment forming bacteria ; various shades of black and brown are the usual colours produced ; and he separated by cultivation twelve organisms which developed lactic acid in the mouth, and states that a great many of the oral microbes are capable of generating acid from cane or grape sugar, and that it is probable that all of them, under favourable circumstances, are capable of so doing. According to Arkovy, one of the organisms most frequently found in dental caries and in the pulp is bacillus gangrenæ pulpæ. Its relative frequency compared with other organisms is 9·53 per cent ; the next most frequent, staphylococcus pyogenes aureus, 23·2 per cent; streptococcus citreus, 4·6 per cent; bacillus pyocyaneus, 9·3 per cent; and some nine other organisms, mostly harmless. Bacillus gangrenæ pulpæ is a pleomorphous organism, forming bacilli when grown on nutrient jelly, and cocci when grown on agar agar. Pure cultures of this microbe have the specific effect of producing gangrene of the dental pulp. This microbe also has the power of softening dentine, and forms a brown pigment in the hot incubator. The presence in the mouth of such large numbers of micro-organisms, many of them pathogenic, suggests the possibility of infection, and that this frequently occurs in the septic mouth full of diseased and abscessed teeth no one can doubt (Fig. 14).

Infection may be induced—

1. As a result of abrasions, wounds, ulcerations, etc., of the mucous membrane of the oral cavity.
2. Through exposure, ulceration, or suppuration of the dental pulp, leading to apical abscess, and eventually to fatal septic poisoning.
3. From absorption of bacterial products, ptomaines, etc.—local.
4. From swallowing bacteria or their poisonous products, inducing gastric, intestinal, or other disorders.
5. From debilitated and diseased conditions of mucous membranes, making them more susceptible to infection.

Professor Miller, and more recently Dr. Hunter, have shown that locally such diseased conditions as necrosis, cellulitis, meningitis, ostitis, periostitis, and pericarditis may have their origin as a result of organismal oral infection, while the stomach and intestinal tract, owing to the numerous microbes and their products swallowed, are liable to be affected by gastric or intestinal disorders. No doubt large numbers of the microbes swallowed are destroyed by the free HCl, but if this state of infection continue for any length of time, the resistance is lessened, or absolutely lost, and conditions of disease are induced. Professor Miller demonstrated that mice and other animals inoculated with saliva (mixed infection) invariably died in from twelve to thirty-six hours. He also tried experiments of pure cultures of four organisms obtained from diseased mouths—

1. *Micrococcus gingivæ pyogenes.*—Injection under the skin of mice produced abscess, necrosis of skin, and generally death. Abdominal injections caused death in from twelve to twenty-four hours.
2. *Bacterium gingivæ pyogenes.*—Abdominal injections, death from ten to twenty-four hours. Subcutaneous injections resulted in the formation of extensive abscesses.
3. *Bacillus dentalis viridans.*—Abdominal injections, death in from twenty-two hours to six days from peritonitis.
4. *Bacillus pulpæ pyogenes* injected into abdomen proved fatal in from eighteen to thirty-six hours.

Tuberculous suppuration in the lymphatic glands of the neck frequently originate as a consequence of the presence in the mandible of diseased and abscessed teeth.

Odenthal examined 987 children, and found carious teeth in 429, in 558 no caries. Of the 558 without caries, glandular swellings were found in 424, or 99 per cent. Hugo Stack (1896) examined 113 children with glandular swellings of neck. In 41 per cent he found carious teeth, and in all of them the situation of the glands corresponded to the affected teeth. In three children with tubercular glands in the neck he also found carious teeth, but could not detect tubercle bacilli in these. In a girl of fourteen years of age, otherwise healthy, he detected a mandibular molar containing tuberculous granulation tissue, and on the side tuberculous glands, while there were none on the other. In a paper read before the Odonto-Chirurgical Society in 1889, the author made the suggestion that tuberculous infection of the lymphatic glands in the neck might originate as a consequence of infection from a diseased tooth, or an abrasion or wound on the mucous surface. A carious tooth with an exposed and inflamed pulp, forming a good nidus for the development of tubercle bacillus, which, being taken up by the blood-vessels of the pulp and deposited in the nearest lymphatic gland, originates the tuberculous condition. This is generally accepted as a fact in the present day. Tubercle bacilli, pyogenic and other bacteria, are frequently found in the tonsils, experiment having proved that tonsillar tissue when injected into animals gives rise to tuberculosis in about 13 per cent of cases (Dieulafoy). The organism associated with thrush oidium albicans is often found in the throat or tonsils of tuberculous patients. The disease called pyorrhœa alveolaris, in which septic conditions are frequently present, is a fertile source of infection in many patients.

Other organisms frequently found in the oral cavity are pneumococci, which may under favourable conditions produce various lesions of the lungs, such as croupous pneumonia, etc. The occurrence of diphtheria bacilli in the healthy human mouth is quite common (Löffler). Recent investigators state that diphtheria bacilli persist in the mouths and noses of patients long after convalescence from the disease. Syphilis: the majority of the cases of infection from this disease have their origin in the oral cavity, being transmitted by the saliva; wounds, dirty instruments in transplantation of teeth, or the use of other people's infected tooth-brushes or pipes, are all frequent sources of conveyance. Actinomycosis very frequently attacks the human subject, infection being conveyed through wounds or abrasions of the mucous membrane, or proliferation takes place in the exposed canals of some diseased tooth. The usual symptoms are numerous abscesses appearing in the neighbourhood of the infected part, discharging profuse stinking pus of a yellowish colour, containing small granules; portions of the ray fungus. 113 cases of actinomycosis in the human subject have been recorded by various authors. In 53 cases out of this number the disease originated in the oral cavity, on the cheek, tongue, jaws, or neck.

Treatment.—In the treatment of oral sepsis all diseased roots and teeth should be removed (the reprehensible practice of some practitioners of cutting over the six front teeth, and without filling and treating the roots, cannot be too strongly condemned), and the patient's health built up with tonics, and light and easily-digested food given, while an antiseptic mouthwash should be frequently used. A teaspoonful of alcoholic solution of hydronapthol in water or phenate of soda may be employed, previous to the use of which, however, a 3 per cent solution of H_2O_2 in water should be employed, the frothing of which helps to remove the débris of food on and between the teeth, and enables the stronger antiseptic to have more effect. An astringent mouth-wash can be used later on: ℞ Tannin ʒj., tinct. iodine ʒss., tinct. pyrethri ʒj., spirit. vin. rect. ℥iss., aqua rosæ ℥vij. Of course, if the teeth are too few to properly masticate with, artificial substitutes should be provided.

Mills and Underwood at the International Medical Congress, London, 1881, presented a communication on dental caries, stating that micro-organisms were always present in dental caries, and were the cause of distension of the tubules, and that two factors were always in operation—(1) the action of acid; (2) the action of germs,—which views were a great advance in the right direction. Shortly after this date Professor Miller, Berlin, began his investigations in regard to the microbes of dental caries and of the mouth generally, and great credit is due him as being the first to demonstrate the true pathology of dental caries. He also succeeded in producing artificial caries in sound teeth by placing them in a mixture of starch and saliva, the starch having been previously sterilised. This mixture was kept at a constant temperature in the incubator, and became acid in from four to five hours. In the course of two or three weeks the teeth were found softened, and presented all the appearances of natural caries—the tubules broken up and distended with micro-organisms. Cultures made from the artificially-produced carious tissue developed organisms which Miller thought identical in form with those of bacillus acidi lactici, and by an elaborate chemical experiment demonstrated the correctness of this view. He also produced artificial dental caries by means of a pure culture of a pleomorphous organism obtained from the mouth.

The exposed portion of the crown of a tooth is covered by enamel, principally made up of lime salts; any defect in its structure is liable to be attacked by the acids generated by the numerous bacteria which find lodgment on and between the teeth, and which, on reaching the dentine, penetrate the tubules rapidly in the direction of the pulp, softening and breaking up the tissues in their progress. Briefly, then, in the process of dental caries there is (1) decalcification of the hard tissues of the tooth by lactic acid generated by microbes; (2) peptonisation and assimilation of the animal matter of the dentine accompanied by alkaline products. Dr. Miller pointed out that micro-organisms grown in different culture materials had a modifying effect on their products; thus proteids caused decomposition, with alkaline products, hydrocarbons had little or no effect, carbohydrates developed acid. Structural defects both of enamel and dentine predispose to attacks of caries, although, according to Black, etc., the hardness or softness of a tooth has nothing to do with its predisposition to caries. Leptothrix forms are very common in the oral cavity, and generally considered to be just transition forms of pleomorphous organisms.

In 1888-95 Dr. Vicentini of Italy made a most interesting and valuable discovery in connection with the organisms associated with caries, and figured and described an organism of a higher type than usually obtains in the mouth, which he says is invariably found in great abundance adhering to the teeth in gelatinous plaques, and which he named leptothrix racemosa. He asserts that this is the parent organism of the most of the bacteria of the mouth, and it certainly looks as if there was some truth in this, as preparations made from scrapings of teeth exhibit all the different varieties usually found in the mouth as well as the characteristic peculiarities of L. racemosa. Vincentini showed chromo drawings of this organism, and represented it as exhibiting four different stages, and that the highest of which was an arrangement of spores round a central stem forming club-shaped masses, and that the organism which produced these spores was the parent form of the whole, or nearly the whole forms of microbes of the mouth; leptothrix filaments, so common in the mouth, being just portions of the stems. He described the parent organism as being composed of fertile filaments or stems, containing in their interior gemules, and attached round their stems by very fine threads were a series of spores in six or more longitudinal series. Little or no attention was paid to this important communication for some years, till Mr. Mummery and Professor Miller took it up, and were able to make out with certainty the club-shaped bodies, etc., described. Later on Dr. J. Leon Williams worked at the subject, and was able to show by means of a series of beautiful photomicrographs the various forms assumed by this organism, and established beyond doubt that this is a new and hitherto undiscovered micro-organism. It is most remarkable that this microbe has so long been overlooked by bacteriologists. Dr. Williams suggests that this was probably due to the fact that it can only be demonstrated by special methods of staining and mounting, for if mounted in balsam it does not show up at all. Dr. L. Williams' method in the preparation of specimens is as follows:—

Wash with a stream of sterilised water the surfaces between two teeth, and with a small sterilised knife scrape the surfaces; the pasty-looking mass so obtained is placed in a clean watch-glass and covered with 20 or 30 drops of a rather watery solution of methyl violet in aniline water for twelve hours, occasionally teasing it apart so as to allow the stain to penetrate; pour off stain, and wash with sterilised water, and then with equal parts of glycerol, alcohol, and water; remove this and put a drop of same mixture on a clean cover-glass, put stained mass into it, and invert on a clean glass slide, when it can be examined with the microscope. Dr. Leon Williams has done good work, and greatly enhanced our knowledge in respect to the pathology of the enamel, and likewise in regard to the bacteriology of the mouth generally.

Mr. Goadby, having received a grant from the British Medical Association, has recently been making investigations in regard to the bacteria of the mouth, and has succeeded in cultivating bacillus maximus buccalis, (leptothrix buccalis maxima of Miller), spirillum sputugenum, and spirochœta dentum, by growing them on potato gelatine, and by so doing has demonstrated that leptothrix thread forms of various bacteria are just involution forms of various bacilli, etc., found in the oral cavity. It might be noted here that bacillus maximus buccalis occurs especially in dirty and unclean mouths full of carious teeth. Spirillum sputugenum has never before been cultivated, therefore to Mr. Goadby is due the credit of having been the first to do so. He obtained in twenty-four hours beautiful spiral and coma forms of this organism. Some years ago the coma bacilli of the mouth were supposed to be the same as the true cholera organism. Goadby clearly defines the differences between them. Spirochœta dentum is frequently found in the pus of alveolar abscess and in chronic empyema of the antrum, while spirillum sputugenum is always found associated with inflamed and filthy conditions of the oral cavity. Mr. Goadby by his research has materially advanced our knowledge of dental caries, and classifies the microbes into (1) acid-forming bacteria, (2) bacteria which liquefy blood-serum, (3) pigment-forming bacteria, and insists that both the superficial and deep layers of carious tissue should be used to grow cultures from, searing each surface with a hot iron previous to taking material therefrom. Mr. Goadby has noted nine acid-forming bacteria, all of which, with two exceptions, streptococcus brevis and bacillus necrodentalis, were found in the superficial layers. As regards the second group, liquefying bacteria, he found six, of which bacillus mesentericus ruber and vulgatus liquefy blood-serum and dentine, bacillus mesentericus fuscus and bacillus furvus Goadby liquefy both blood-serum and dentine. Besides these two other organisms were noted, the yellow bacillus Goadby, supposed to be Miller's bacillus gingivæ pyogenes, and bacillus fluorescens motilis. Constantly associated with these organisms he found an organism commonly found in sewage, cladothrix dichotoma, and other varieties of putrefactive bacteria have been found by him in the human mouth, and also in those of monkeys associated with dental caries. All caries organisms grow best when the culture material is alkaline and contains carbohydrates. Choquet has recently shown that recurrent dental caries can be produced in a sound tooth cavity, and below a tight filling, by placing a small metal cap of culture material on the bottom of the cavity previous to filling it, but owing to the absence of carbohydrates this secondary caries seems to advance very slowly and affects only a limited area.

Neuralgias of Dental Origin

Certain individuals seem to have a neuralgic tendency, the slightest cause interfering with perfect health inducing an attack, and there is nothing more certain than that conditions of debility, anæmia, malaria, or exhaustion are fertile sources for originating this complaint in subjects prone to it. When it has its origin in the branches of the fifth nerve it is termed trifacial neuralgia—supraorbital, infraorbital, temporal, aural, or cervical being the regions most affected. And any tooth or teeth in a diseased or irritable condition are liable to originate an attack. Careful examination requires to be made of all the teeth in order to diagnose the origin of such neuralgic conditions. The teeth one by one should be thoroughly examined with a fine probe, and percussed by a steel instrument, while conditions of chronic pulpitis, exostosis, chronic periodontitis, or impacted third molars must not be overlooked. Projection of a stream of cold water against a suspected tooth may help to show up inflammatory conditions of the pulp. Carious, suppurating, and broken-down wisdom teeth are common sources of neuralgic trouble.

Neuralgic pain, when occurring in the supraorbital or infraorbital regions, is usually due to maxillary teeth, whereas pain in the ear, neck, or shoulder indicates disease of some of the teeth in the mandible. The pain of neuralgia is of a sharp, paroxysmal, darting, or burning character, and sometimes the attacks come on at stated periods and intervals.

The pathological conditions of teeth which more especially are the cause of neuralgia are: (1) irritation of the pulp; (2) chronic pulpitis; (3) chronic periodontitis; (4) the various forms of secondary dentine found in the pulp chamber, especially that form called dentine excrescence and calcareous granules; (5) exostosis; (6) impacted third molars. It is frequently very difficult to differentiate between neuralgias of a general or dental origin. A preliminary dose or two of tincture gelsemium is sometimes of use in diagnosis, as it gives relief in most cases of dental origin, but is of no effect in systemic conditions. The treatment of the various pathological conditions of the teeth, in so far as this can be done, quickly allays and stops short the neuralgic symptoms, but while it lasts relief can be obtained by the administration of phenacetin or tincture gelsemium. Neuralgic pain may be reflected from one nerve to another, and produce pain at a considerable distance from its origin, such as the neck, the arm, or back. The usual sites of the affection are at the outlets of the main branches of the fifth nerve on the face and head. Facial paralysis is a pretty common affection, as a result of diseased and abscessed mandibular molars. The author has seen a case of muscular paralysis of the arm which was cured by the extraction of a diseased mandibular third molar. Various affections of the eye, according to Power, are caused by the presence of suppurating teeth in the maxilla.

Antrum Empyema.—The maxillary antrum is very variable in size; sometimes the two sinuses differ in size in the same individual. The antrum is of pyramidal shape, and is situated above the roots of the posterior teeth and below the orbit. The proximity of the roots of the posterior teeth to the cavity of the antrum (which they sometimes penetrate) is frequently the origin of trouble in this sinus by causing irritation and alteration of the normal secretion, which becomes purulent in character, and is evacuated through the middle meatus into the nose, or in some cases a sinus discharges through an opening in the external alveolar process or palate. Antrum empyema may also have its origin as an extension of disease from the nasal cavity without any of the teeth being diseased; but its most frequent origin is from diseased and septic roots or teeth, especially the posterior teeth, although any of the other teeth may cause it.

Acute Antrum Empyema.—Except as a result of scarlet fever or influenza this variety is somewhat uncommon.

Symptoms.—Great pain of a throbbing or neuralgic character is experienced, accompanied by high temperature and pain in the teeth. Relief for the time being is obtained by evacuating the cavity. Operative measures are seldom required, as the disease ceases spontaneously.

Chronic empyema is very common and often overlooked. Symptoms: slight feeling of pain or tension over the cheek, nose, or supraorbital ridge, nasal discharge of fœtid pus, the frequent passage of which over the nasal mucous membrane irritates and inflames it; one or both nostrils may be blocked. It often requires prolonged treatment and is difficult to cure.

Treatment.—Remove thoroughly all diseased teeth, and bore a hole with a suitable instrument (a large trochar will do) through the external alveolar plate over the first or second molar tooth into the antrum. A good-sized opening is required for successfully treating it. The antral cavity should then be, in the first place, washed out with dilute 3 per cent solution of pyrozone to cleanse the mucous membrane from pus, etc.; then follow this up with a hot solution of boracic acid, or a teaspoonful of hydronapthol solution in a tumbler of water may be used. This may be done three or four times daily, using an enema syringe. In chronic cases curetting the cavity is useful, or painting the membrane with equal parts of tincture of iodine and carbolic acid. If these measures fail to arrest the suppuration the antrum should be packed with aristol gauze till suppuration cease. To exclude food, etc., from the antrum, a plate should be adapted to the mouth carrying a tube or plug fitting the opening. In cases of antrum empyema, where the teeth are all sound, an opening may be made into the antrum through the canine fossa, though the drainage from this part of the antrum is not nearly so good. Some authorities recommend opening through the nose (Max, Hall, etc.).

TOOTH EXTRACTION. HÆMORRHAGE

In extracting teeth with forceps the rules to remember are to press the instrument forcibly upwards or downwards, as the case may be, keeping up this pressure during the whole time the lateral movements are being made, while one or two fingers should be placed between the handles of forceps to regulate the pressure applied to the tooth (Fig. 15). In the maxilla the only teeth that can be rotated in extracting are the canines and central incisors; all the other teeth, both in the maxilla and mandible, except inferior canine, are best removed by an inward and outward, more especially outward, movement, the external alveolar process being thinnest and yielding more readily. Hawksbill root forceps are usually employed for the extraction of all mandibular teeth up to the second premolar, while hawksbill molar forceps are employed for the posterior teeth (Fig. 15). In using the hawksbill molar forceps for, say, the extraction of the first molar, the tooth should be grasped, and the index and other fingers of left hand should rest on the teeth and inner surface of alveolar ridge, and the thumb should be used to forcibly press down the beaks of instrument. Root forceps are usually employed for the extraction of the maxillary teeth up to the second premolar; the usual beaked forceps are used for the molars (Figs. 16, 17, 18). For the extraction of roots where forceps are of no avail, the elevator, straight and curved, is very useful. The straight elevator is invaluable

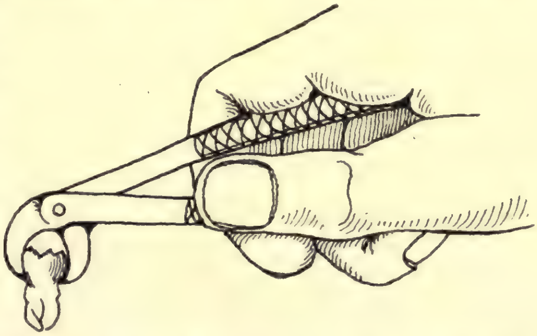


FIG. 15.—Method of holding hawksbill forceps for extracting a molar tooth.

in the removal of mal-placed wisdom or other teeth in the mandible, and is used thus: it is gradually, and with a somewhat rotatory movement, forced well down between the tooth and its socket, then leverage is applied, which gradually forces the tooth out of its socket (Fig. 19).

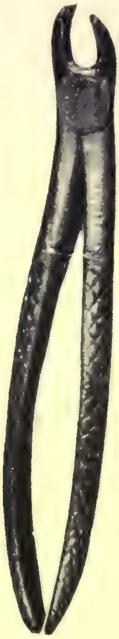


Fig. 18.

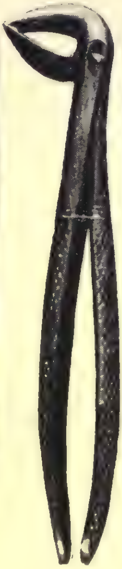


Fig. 16.

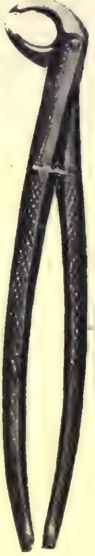


Fig. 15.

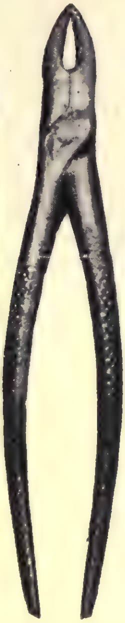
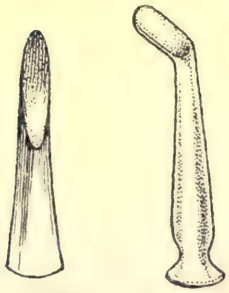


Fig. 17.

Alveolar Hæmorrhage.—Hæmorrhage after tooth extraction is sometimes troublesome, especially in patients of a hæmorrhagic diathesis, in which class of cases it is advisable, as a preventive, to prepare the patient, prior to the removal of a tooth, by administering twice daily one 4-gr. acetate of lead pill for a week previous to the operation, or doses of tannic acid; and to make sure, the sockets of tooth, after extraction, should be separately packed with narrow strips of lint saturated with Richardson's styptic colloid, a preparation which almost invariably checks hæmorrhage. Adrenalin chloride is also very valuable to allay hæmorrhage.

Hæmorrhage, as to cause, may be either traumatic or vicarious of some other blood-flow. In very obstinate cases, after plugging the sockets, a piece of cork may be fitted between the two teeth on either side and the jaws bandaged, so that the opposing teeth may keep up pressure on the cork, or a piece of softened guttapercha may be moulded and applied in like manner. The capillary ooze from the gum is sometimes more troublesome to control than the alveolar.


Straight elevator. Curved elevator.
Fig. 19.

Local anæsthetics used in tooth-extraction are—

Chloride of ethyl, which is sprayed on the gum from a tube, and is sometimes of use, especially for the removal of loose teeth.

Eucaine.—A solution in water is greatly used, hypodermically applied; it has little or no toxic effect, and is preferable to cocaine. If several teeth have to be extracted, three or four different injections at various points over the roots of the teeth should be given, and in five or seven minutes the teeth can be removed. Nitrous oxide gas as a general anæsthetic is very extensively used by dental practitioners, but the author prefers a mixture of N_2O, 1 part to 1 part of O. The anæsthesia is more prolonged than with N_2O alone; there is no stertor nor cyanosis, and no spasms of the muscles. N_2O anæsthesia may also be kept up by the application, after removal of the face-piece, of a nose-piece through which the gas is administered, and it can thus be prolonged so that nearly the whole of the teeth in the jaws can be extracted at one sitting. It is of no use, however, in cases where there is nasal obstruction. N_2O and ether for prolonging anæsthesia is greatly used and gives very good results; along with ether it forms the principal anæsthetic agent now employed at the Edinburgh Dental Hospital for dental operations. Kelene, a form of pure ethyl chloride, inhaled through a special face-piece, is sometimes employed, and is both very simple and efficient, and is useful to employ for outside cases where the taking about of the gas apparatus is troublesome. No disagreeable effects seem to be caused by its use, and from two to eleven teeth can be extracted under the anæsthetic.

MECHANICAL DENTISTRY

Dentistry is a very old profession, and was practised by the Romans at a very early period, as we learn from the Twelve Tablets promulgated some 450 B.C. In it mention is made of the fixation of loose teeth by means of gold wires, a common proceeding in those days. In the Museum of Corneto, Italy, there are two plates with artificial teeth attached, which were got from an Etruscan and Roman tomb respectively, dating back to the fourth or fith century B.C. The teeth, which are carved out of ivory, are fixed upon a thin flexible ribbon of gold.

Owing to the great destruction of teeth from caries in the present day, immense quantities of porcelain teeth are required yearly to meet the demand. Artificial teeth in the present day are all made of porcelain. Fifty or sixty years ago natural teeth, or teeth carved out of walrus or other tusks, were largely used, but had the fault of becoming carious, and so did not last any time. Porcelain teeth are mainly made up of a mixture of kaolin, silica, feldspar, and oxide of titanium, the glazed enamel surface being made with feldspar and various colouring matters to produce the shades. The teeth are made in moulds and then fired; each tooth has two platinum pins baked into it for fixing them to the various base plates they may be put on.

The mouth should be prepared for the insertion of artificial teeth by the removal of all useless or diseased roots, and the treatment and filling of all salvable teeth, to prevent caries and abscess; the six front maxillary roots should be treated and filled if possible, as their retention does not alter the mouth so much, and does not necessitate an artificial gum. After preparation of the mouth the model is taken. The best material for this purpose, especially in edentulous patients, is plaster of Paris, but modelling composition made up of gum-kowrie, stearin, chalk, and colouring, is also extensively employed. Everything depends on the model being accurate, otherwise the plate will not fit. After the model is cast it is dried and boiled in liquid bees'-wax or stearin to harden the surface, and if a metal plate has to be made casts of the model in zinc are taken in sand, and a counter of lead made to fit it, between which the metal plate is swaged and struck up till it fits the model perfectly; it is then filed up to shape, and the teeth, backed with platinum or gold, are fitted to the gum, waxed into position on the plate, and articulated; then the plate and teeth are embedded in a mixture of plaster and diatomite, leaving the backs of teeth and palate of plate exposed. When hard the wax is removed, and the whole gradually heated up till red-hot on a fire or gas-burner, and each tooth soldered to the plate with gold solder by means of a blowpipe; after which the plate is finished and polished. For the retention of partial dentures the teeth are fitted with clasps of springy gold, but as these sometimes act injuriously on the teeth it is better, if possible, to retain the plate with flexible gold wings, carefully adapted, high up on the external alveolar border, and running from behind forwards. When a vulcanite denture is made a wax plate is prepared to fit the model, then the teeth are ground and fitted to the gum, waxed to plate, and articulated to the bite; after smoothing and finishing, it, along with the model, is embedded in plaster in the lower half of a flask, all the teeth being covered with plaster up to their inner surfaces, but leaving the palatine surface of wax-plate exposed. When the plaster has set it is smoothed and greased, and the other half of flask put on and filled up with plaster; when hard the two halves are separated, the wax-plate all removed with boiling water, and vulcanite rubber is cut in suitable pieces and packed into every part of it till full; the flask is now heated and compressed, and is ready for vulcanisation, which consists in subjecting the flask and contents to a temperature of 315° to 320° F. for an hour and a quarter in a steam boiler, which converts it into hard vulcanite. After cooling and removal from the flask it is scraped, filed, and polished. In the case of full-suction sets the models should always be taken with plaster, as it causes less disturbance of the soft parts, and great care requires to be taken in getting the correct bite and proper articulation of the teeth.

Gold springs and swivels are sometimes employed for attaching the two dentures to each other, but in the majority of cases springs are not required, except perhaps with very old people, because, if the adaptation and model be correct, suction-plates ought to keep in place perfectly. Suction-cells for retention of the upper plate are used by many, but are of little value, and have been known, by their irritation, to originate malignant disease. Badly adapted plates cutting into the soft tissues are a source of danger, as they are sometimes neglected, and produce troublesome ulcerations which are prone to become malignant.

Bridge and Bar Work

This method of inserting artificial teeth has, during recent years, been much exploited by the more unscrupulous class of practitioners, who insert bridge work in all and sundry, whether the case is adapted for it or not, and without proper treatment of the roots and teeth of attachment (Fig. 20). The method is this: In a mouth, say, with a molar on either side left, and two canine roots, the two sound molars are cut down and caps of gold are fitted over them, the two roots are treated and cut level with the gum, and their root canals enlarged; platinum caps are now fitted to each root, and a tube running up each canal is soldered to them, and the two cemented into position. A stout platinum bar is fitted to go from molar to molar, soldered to each cap and to the two metal posts fitted to each tube in roots. Backed

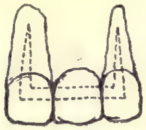


Fig. 20.—Small bridge-work plate attached to roots of central and lateral incisor.

teeth are now adjusted, fixed in position, and soldered to the bar, and when finished and polished it is cemented into place. The objections to this class of work are: the difficulties of repairing and keeping it properly clean, the maiming of sound teeth is a decidedly objectionable feature, and if badly adjusted the strain on the teeth to which the bridge is fixed gradually loosens them. Movable bridge work, when it can be applied, is not quite so objectionable (Fig. 20). Pivots are used extensively for the six front teeth, the pulp is destroyed and removed, the root canal enlarged, and the apex sealed up with guttapercha; a post of gold or platinum is adapted to the root canal, and soldered to a platinum cap made to fit the root surface, which has previously been filed down a little below the gum level in front, but not so much behind, then a backed half tooth is fitted over the cap and to the gum, and soldered to it, building the back up with gold to a contour; after being filed up and polished it is made fast in the root with cement or guttapercha. All porcelain crowns are extensively used also, especially premolars and molars. A square post is fitted and cemented into the root, and a tube tooth is adjusted over the root and cemented to the root and outer part of post, or the tooth may be fixed with amalgam. Other porcelain crowns have platinum posts embedded in the tooth, which, along with the tooth, are fitted to the root, and then fixed into place with cement, etc. All gold crowns are principally used for the posterior teeth, and are best adapted for roots which have a portion of the tooth remaining above the level of the gum. A ferule of 22-carat gold is fitted to go below the edge of the gum and fit tightly to the root, and with crown punches a top is struck up, strengthened, and soldered to the ferule, which, on being filed, polished, and fixed, makes a very good and serviceable crown.

Gold and porcelain crowns are sometimes made from all-gold crowns by cutting out the outer metal wall, and fitting into it and soldering a half tooth which has been backed with gold. They are very much more presentable than all-gold crowns, and should be used near the front of the mouth in preference to the all-gold crown.

Telegrapher's Cramp. *See* NEUROSES, OCCUPATION.

Temperature.

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THE temperature of the body is the degree of bodily heat registered by the thermometer. The temperature of the internal parts of the body is higher than that of the more superficial or peripheral parts. In man the normal temperature taken in the mouth or axilla is 98·4° to 98·6° F. (37° C.); the average temperature taken in the rectum is 99·3° F. (37·4° C.), whereas the skin temperature varies from 81° to 89·6° F.

As there is constant production of heat within the body, the result of tissue metabolism, it is evident that there must likewise be constant loss of heat. The temperature of any part of the body is largely dependent on the amount of blood circulating through the part, and consequently on the degree of dilatation or contraction of its blood-vessels.

Division of the sympathetic in the neck of the rabbit is followed by dilatation of the blood-vessels and elevation of temperature in the ear of the same side, whereas irritation of the peripheral end of the divided nerve causes contraction of the blood-vessels in the ear with a fall of temperature in the part.

The constancy of the temperature of the body is due to the intimate relationship between the amount of heat produced and that lost from the body. Loss of heat occurs to a considerable extent from the lungs, but is chiefly due to radiation, conduction, and evaporation from the skin. The loss of heat by evaporation diminishes the more moisture there is in the atmosphere, hence a high temperature of the atmosphere is more readily withstood the less moisture it contains. The loss of heat from the skin is reduced by clothing, but apart from this, the loss of warmth from the skin is automatically regulated. Exposure to cold tending to cause loss of heat from the skin surface, induces at the same time contraction of the cutaneous blood-vessels, and thereby lowers the temperature of the skin, diminishes the evaporation of moisture from it, and checks the loss of heat from the body. On the other hand, if the temperature of the medium surrounding the body be high, the blood-vessels of the skin dilate, the amount of blood circulating through the skin is much increased, and there is consequently increased loss of heat from the surface of the body. Thus, in the event of circumstances tending to cause a rise of temperature, there is a compensating lowering of the temperature; or if there be a tendency for the temperature to fall, there is a simultaneous and compensating rise of temperature. In this manner the range of temperature in normal individuals is very slight, a rise or fall of temperature is of brief duration, and the normal temperature is quickly re-established.

THE TEMPERATURE IN RELATION TO AGE.—In new-born infants the mean temperature is 99·0° to 99·6° F., and in both infancy and childhood variations in temperature are more frequent and more pronounced than in later life. New-born infants not infrequently present an evening rise of 0·9° F. In advanced life the temperature is often slightly higher than in the normal adult, being usually about 99° to 99·5° F.

DIURNAL VARIATIONS OF TEMPERATURE occur both in health and in disease. In the former, and probably also in the latter, the variation is mainly dependent on muscular movements and ingestion of food. According to Ogle the minimum temperature in health is about 6 A.M. (97·2° F.). A rise of temperature then commences and continues until the maximum temperature (about 98·7° F.) is attained between 3 and 5 P.M., and thereafter the temperature again falls. Jürgensen observed the daily minimum between 2 and 8 A.M., the daily maximum between 4 and 9 P.M.

The temperature is uninfluenced by the sex of the individual. Menstruation causes a very slight and transient rise of temperature; pregnancy has no effect on the temperature. During parturition there is a rise of about $\frac{1}{10}$° F.; during the normal puerperium the temperature remains the same as that of other normal women.

Tea and coffee induce a slight rise, usually about ½° F. or less; alcohol in large doses lowers the temperature in consequence of dilatation of the superficial blood-vessels, and of oxidation being retarded, but after this fall the temperature rises to a higher level than formerly.

LOCALISED ABNORMAL TEMPERATURE.—A localised abnormality of temperature is most frequently and readily observed in a peripheral part of the body such as the limbs. The two chief factors concerned in bringing about this change are the vascular and the nervous supply of the part. Arrest of blood-supply, as by ligature of the main artery to the part, causes a marked fall of temperature locally, which is in turn succeeded by a rise as the collateral circulation becomes established. Disease of the blood-vessels, causing diminution of blood-supply to a part of the body, is usually accompanied by a fall of temperature in the affected part. Such a change is well seen in the fingers in Raynaud's disease, and may be observed in cases of advanced arterio-sclerosis. Paralysis of a peripheral nerve, whether resulting from section or injury of the nerve trunk, neuritis, or other lesion, the lower neuron of the motor path, is frequently accompanied by diminution of the temperature in the paralysed part, and the difference between the surface temperature of the healthy and of the paralysed side may amount to 10°, 15°, or 20° F.

A localised elevation of temperature is essentially due to an increased volume of arterial blood in the part. Claude Bernard's classical experiment on division of the sympathetic in the neck of the rabbit with consequent elevation of temperature of the ear on the same side has been already mentioned. A localised elevation of temperature consequent on local dilatation of the blood-vessels is observed in association with cutaneous hyperæmia of superficial parts whether it be induced by mechanical means or be a manifestation of inflammation, but the temperature of the affected part is never higher than the general temperature of the body.

Alterations of General Temperature.—The general temperature of the body may either fall below or rise above the normal level.

A. *Depression.*—It is evident that a fall of the general temperature may be due (1) to diminished production of bodily heat; (2) to excessive loss of heat; or (3) to these two processes acting in combination; but it is not always possible to determine to which of these factors depression of the general temperature is due. The fall of temperature consequent on extensive burns of the skin is, however, due to increased loss of heat dependent on paralytic dilatation of the blood-vessels in the injured parts. Prolonged *exposure to cold* also causes excessive loss of heat from the body; and if this loss be continued for a long period, the temperature of the body may be reduced to such a degree that the life of the individual is endangered, or that death ensues. In animals, death from freezing is mainly due to paralysis of respiration, for by means of artificial respiration the animals can be kept alive for longer periods than they could otherwise be. The temperature falls after the occurrence of a severe *hæmorrhage.* In animals a hæmorrhage of moderate amount causes the temperature to fall about 1·5° to 1·8° F. This fall is maintained for a few hours, but thereafter the temperature rises to a higher level than that existing before the hæmorrhage occurred. The loss of a larger quantity of blood is followed by a rapid and marked fall of temperature, whether the temperature previously has been normal or elevated. Such a fall of temperature is of great significance in typhoid fever, and in duodenal and many cases of gastric ulceration.

Starvation and *vomiting* lower the temperature. In *collapse* there is a marked fall of temperature due chiefly to rapid and excessive loss of heat. In severe collapse, associated with serious danger to the life of the patient, the temperature may fall to about 93° F. In many patients suffering from chronic diseases the temperature is subnormal. Examples are seen in cases of chronic nephritis, cerebral abscess, and enteritis, though in the latter condition a febrile temperature is not uncommon, especially in children. In such cases depression of the temperature is due more to deficient production of heat than to excessive loss of heat. A reduction of temperature can be effected by certain *drugs,*—alcohol, chloroform, ether, opium, and chloral, for example. The group of drugs termed antipyretics, which bring about a reduction of an elevated temperature, have little if any effect in rendering a normal temperature subnormal. The antipyretics will be again referred to in dealing with the treatment of fever.

B. *Elevation of the General Temperature.*—Elevation of the general temperature may be induced (1) by increased heat production, (2) by diminished loss of heat, or (3) by these two processes in combination. The term fever is employed by some writers to signify elevation of temperature induced by no matter what cause, but it is more usual not to regard mere elevation of temperature, or hyperthermia, and fever as synonymous terms, but to reserve the term fever for a general disturbance of metabolism, one of the main features of which is an abnormal elevation of temperature. It must, however, be admitted that in some instances it is difficult or impossible to determine whether the elevation of temperature is a simple hyperthermia or a febrile pyrexia.

Hyperthermia may be induced by muscular exertion, exposure to high temperatures, or by lesions of the central nervous system.

Muscular exertion, especially if prolonged, causes a rise of temperature by increasing the production of heat within the body. Sutherland Simpson has recorded the fact that muscular exercise in the monkey causes the rectal temperature to rise from 3° to 4° F. In man active muscular exercise causes an elevation of temperature of about 0·5° to 2° F. This hyperthermia, due to increase of metabolism in the muscular tissues, ceases simultaneously with, or very soon after, the muscular exercise is discontinued, provided the individual be in normal health. If, however, he be affected with some morbid condition, or be convalescing from disease, muscular exertion not only tends to induce a more marked rise of temperature, but this elevation tends to persist for a varying period of time after cessation from the muscular exercise.

On exposure to an atmosphere of a high temperature, which tends to raise the general temperature of the body, there is, as already mentioned, a simultaneous and compensatory excess of heat lost from the skin. But prolonged exposure to a very high temperature cannot be withstood without harm resulting. If guinea-pigs be exposed to a temperature of 104° to 107° F. their temperature rises to 107° to 113° F., and the animals die; whereas if animals be exposed to a gradually increasing high temperature they remain alive even though the temperature of the atmosphere be raised to 105° to 107° F. After exposure to such a temperature there is marked degeneration of the red blood corpuscles and fatty degeneration of the parenchyma of the liver, heart, and kidneys, but the blood pressure may remain normal. If the human subject be exposed to a temperature of 122° F. his temperature rises to 107° F. or still higher, and death may ensue. Similarly in the case of sunstroke the temperature, in consequence of diminished loss of heat, rises, it may be, to 104°, 105°, or even to 113° F. The skin is hot and dry, the respiratory and cardiac frequency are both markedly increased, and there is increased excretion of urea from the kidneys. The increased rapidity of the respiration is usually ascribed to the heat of the skin stimulating the respiratory centre reflexly.

Hyperthermia of Nervous Origin.—The experiments of Wood, Eulenberg, and Landois, Bokai, and others, on the production of hyperthermia by injuries to the cerebral cortex are inconclusive, the high temperature being probably due to muscular movements of the animals, or to the epileptiform attacks induced by cortical stimulation. Aronsohn and Sachs, Ott and Hale White found that in animals lesions of the corpus striatum are followed by a rise of temperature to 107° F. or more. Both clinical and experimental evidence indicates, however, that there are no specific thermogenic centres or centre within the central nervous system. A cerebral lesion associated with hyperthermia is probably in every instance an irritative lesion, but whether the hyperthermia be the result of increased chemical activity in the muscles or glandular organs, or be dependent on diminished loss of heat, is still unascertained. In man hyperthermia is seen in association with injuries to the cerebral cortex, corpus striatum, or crus cerebri, with lesions of the pons and medulla, and also sometimes with hysteria, epilepsy, and general paralysis. In hysteria the temperature may rise to

106° F., being in some instances associated with convulsive attacks. In diseases associated with a febrile elevation of temperature there is in some instances a rise of temperature to 107° F. or more, constituting the condition known as *hyperpyrexia.* The hyperpyretic temperature is by some regarded as representing the joint result of the febrile temperature and of a hyperthermia of nervous origin.

FEVER.—In fever there is a general disturbance of metabolism with elevation of the temperature (pyrexia), disturbance of the circulation and respiration, alterations in the blood and urinary secretions, and changes in the parenchyma of the internal organs. The functional and structural changes are due to the exciting cause of the fever, and are not the result of the rise of temperature.

Elevation of the temperature is the most important and characteristic sign of fever. The rise of temperature is probably not in all cases induced in the same manner, though this is a point on which different investigators do not agree. It is usual to describe three stages in the course of the febrile temperature :—

(1) The initial stage of rise, pyrogenetic stage, or stadium incrementi. In this stage the cutaneous blood-vessels become contracted in consequence of the action of the exciting cause on the vaso-motor centre, and the vascular constriction becoming more pronounced, there is diminished loss of heat from the body, and the temperature commences to rise, and continues to do so the more markedly the cutaneous blood-vessels become constricted. The initial rise of temperature is therefore dependent on a diminution in the loss of heat. If this constriction of the cutaneous blood-vessels be rapidly induced the general temperature rises rapidly, as in scarlet fever or acute lobar pneumonia, whilst there is a fall of temperature in the peripheral parts, pallor of the skin, a sensation of cold, and a rigor which ceases before the temperature has attained its maximal point. If the exciting cause of the fever induces a gradual constriction of the blood-vessels, the initial rise of temperature is not sudden and is not associated with a rigor, but is gradual, slow, and more or less insidious. It is either a gradual but steady rise, or there are several more or less well-marked remissions, after each of which the temperature rises to a higher level than it had previously attained. The best illustration of such a step-like rise is seen in the temperature during the first week of typhoid fever.

(2) The stage of acme, or the fastigium, during which the temperature remains elevated, though varying according to the exciting cause. During this stage of fever there is an increase both in the production and in the loss of heat, an increase which, according to Krehl and Matthes, is on an average equal to 20 per cent. But even though there be, as compared with the normal, an increased loss of heat, the loss is insufficient to entirely compensate the excess of heat produced, and the temperature is consequently above the normal level. In many instances the skin is dry, and evaporation of moisture from the surface of the body is diminished, and the loss of heat is, in comparison with the production of heat, relatively diminished. During this stage the height to which the temperature rises, and the general course of the temperature, are dependent on the exciting cause, but the same cause may not induce an identically similar reaction in every case, as different individuals may react to the same cause in a different manner. There are a number of "clinical types" of febrile temperature according to the course of the latter. Thus the temperature may remain at a high level for a short period, varying from some hours to a few days, after which it rapidly falls. This type is termed accuminated,

and is observed in many acute infective diseases of short duration. Again, the temperature for a prolonged period may remain persistently high with diurnal variations. This is the continuous type of temperature, examples being the temperature of typhus fever, acute lobar pneumonia, and acute suppurative meningitis. Again, there may be during this stage marked fluctuations in the course of the temperature. Thus there may be a remission of the temperature in the morning and an exacerbation in the evening. In this remittent type of temperature, as in typhoid fever, for example, the temperature during the remissions does not fall to the normal level. In the true intermittent type the temperature at each successive fall reaches the normal level, examples of this type being the temperatures in malarial fever, the fever of septic origin, and advanced pulmonary tuberculosis when there is mixed infection with streptococci. In the relapsing type of febrile temperature there is a paroxysmal elevation of temperature persisting for a few days to a week, then a rapid fall of temperature, succeeded by an interval during which the temperature remains normal, and subsequent to this interval there is again a paroxysmal rise.

(3) Defervescence, or stadium decrementi, the stage during which the temperature falls to normal. Defervescence occurs when the exciting cause of the fever ceases to act—when, for example, the causal toxin becomes completely united with the specific antitoxin. The fall of temperature is sometimes associated with marked dilatation of the cutaneous blood-vessels and with considerable sweating, and there is, in this instance, a rapid fall of temperature constituting a crisis. During a crisis there are often signs of collapse. There is not infrequently a pseudo-crisis preceding the actual crisis. In other instances defervescence takes places slowly, or as it is termed, by lysis, and some days or even a week may elapse before the temperature has actually fallen to the normal level.

The preagonic temperature may rise to a very high level, 105° to 107° F. or more, as in cases of cerebral lesions, hæmorrhage, meningitis, etc., and in tetanus. Preagonic hyperpyrexia is possibly due to a nervous hyperthermia, consequent on cerebral disturbance, being superadded to the pre-existing pyrexia, or may be due to a terminal infection. It is more usual, however, for a temperature, which was previously high, to fall, it may be to below the normal level in the period preceding death. *After death* the temperature of the body gradually falls to that of the surrounding atmosphere. In some instances, however, there is an initial post-mortem rise of temperature which may be very pronounced (104° to 111° F.) Such a rise is, for example, seen in some cases of cerebral hæmorrhage, cerebro-spinal or tuberculous meningitis, tetanus, acute rheumatism, and other infective diseases in which there has been marked pyrexia or hyperpyrexia.

CAUSES OF FEVER.—The most frequent and important causes are bacterial toxins. Bergmann and Brieger both prepared toxic bacterial products capable of inducing febrile elevation of temperature. Donath found that a substance (pyrotoxin) of a pyrogenetic nature could be obtained from a number of bacteria such as staphylococcus pyogenes aureus, streptococcus pyogenes, and bacillus pyocyaneus; and Krehl obtained similar results in the case of bacterium coli commune, diphtheria bacillus, proteus vulgaris, and other pathogenetic and saprophytic bacteria. Tuberculin and tetanus toxin likewise induce elevation of the temperature. In contradistinction to Centanni, who considers that the pyrotoxin obtained from different bacteria is in all cases identical, Krehl holds that the pyrogenetic substances of the various bacteria are not identical in all respects. The latter view is certainly the more correct if one considers how different is the character and course of the temperature in the various febrile diseases, such as acute lobar pneumonia, acute rheumatism, diphtheria, typhoid fever, etc.

Bacterial toxins are, however, not the only cause. Pyrexia may be due to a process of autointoxication, to an abnormal absorption of products of metabolism. The pyrexia of intestinal catarrh and constipation is sometimes ascribed to autointoxication, but is more probably due to absorption of bacterial toxins from the alimentary canal. Subcutaneous injection of albumin, albumose, and peptone, and of normal urine, causes a rise of temperature in some animals, and various other substances, urea, nuclein, fibrin ferment, pepsin, trypsin, diastase, and other ferments, have a similar action. Ughetti having found that urea induces hyperthermia, concluded that the rise of temperature in fever was due to the fact that various substances bring about an increased production of urea within the body. Elevation of temperature is often observed in association with aseptic injuries and lesions of the tissues, with internal hæmorrhage, or with anæmia, constituting the form of pyrexia designated "aseptic fever," examples being the so-called urethral fever, and the fever associated with teething, simple fracture of bone, aseptic hæmothorax, hæmarthrosis, etc. In these instances we may either assume that the rise of temperature, which is by some writers interpreted as a simple hyperthermia, by others as a sign of fever, is due to the absorption of albumose, or other tissue product, from the site of injury or from the degenerating tissue cells, although the possibility of the elevation of temperature being in some instances due to reflex nervous stimulation cannot be entirely excluded.

There is very little evidence, if indeed any at all, to prove that pyrexia is harmful. On the contrary, pyrexia of moderate degree is beneficial to the patient; it is only harmful if it be severe or hyperpyrexial. Animals exposed to a high temperature after experimental inoculation with bacteria are enabled to withstand infection better than when they are kept at the room temperature (Walther, Filehne, Rovighi, Kast, Loewy and Richter). We cannot, however, conclude that elevation of the temperature retards or inhibits the growth of pathogenetic bacteria within the body, nor that it tends to lessen or destroy the toxicity of the bacterial products; and although it has been shown that the antibody present in the blood-serum of persons convalescent from typhoid fever, or of goats immunised to the *bacillus typhosus*, is more potent at a high temperature, it is not clear how the beneficial effect of a febrile elevation of temperature on the course of an infective disease is brought about.

Other Changes in the Course of Fever.—Elevation of the temperature may cause some acceleration of the pulse and respiration, but all the other changes to be described occur quite independently of the pyrexia, and are due to the same cause, namely, the toxin.

There is usually, though not invariably, increased consumption of oxygen and increased excretion of carbon dioxide by means of respiration, indicating that there is increased oxidation of the tissues of the body. But there is no constant relationship between the pyrexia and increase of metabolic activity, and the latter is not necessarily the cause of the pyrexia.

Degenerative changes in the parenchyma of the different organs can usually be demonstrated. The most frequent changes are albuminous infiltration, and fatty degeneration of the liver, kidneys, and cardiac muscle, less constantly of other glandular organs. Fatty degeneration can be induced by artificial exposure to a high temperature; but that the degenerative changes in fever are due to the causal toxin, and not to the pyrexia, is shown by the fact that the extent to which the changes occur is not proportionate to the elevation of temperature, and that the changes may be more marked after diphtheria or typhoid fever in which there has been merely moderate pyrexia, than after acute lobar pneumonia associated with a much higher elevation of temperature. Necrotic changes, in the renal epithelium and in striped muscles, for example, are likewise induced by certain toxins.

Changes in the Blood.—In consequence of locàlised congestion of internal organs there may be a diminution in the number of red blood corpuscles per c.mm. in the peripheral blood; but there is usually more or less well-marked hæmolysis causing the anæmia so frequently associated with fever. The presence of hæmosiderin in excess in the spleen is a result of the hæmolysis. In many febrile diseases there is also well-marked leucocytosis, whereas in others, such as malaria and typhoid fever, there is no increase in the number of leucocytes in the peripheral blood, owing in some instances to the withdrawal of leucocytes towards the seat of infection in the internal organs. The blood serum sometimes contains a diminished amount of albumin, and the coagulability of the blood may be either increased or decreased. The alkalinity of the blood and of the blood serum is diminished during the course of a febrile disease, and the reduction is probably the more pronounced in proportion to the severity of the infection. During the periods of recovery and convalescence the diminution of alkalinity gives place to an increase, but if the organism be unable to withstand the infection or the toxin, the degree of alkalinity continues to fall until the fatal issue supervenes, as shown by von Rigler, after injection of diphtheria toxin, mallein, and tuberculin.

Loss of body weight is a constant and marked feature. That the loss is not due to the pyrexia is shown by the fact that a patient loses weight during the course of an infective disease, even though his temperature be maintained at or about the normal level by means of antipyretics. The loss of weight may be in part due to diminished ingestion of food, or to imperfect absorption of food, but is mainly due to degeneration or disintegration of the tissue cells consequent on the action of the causal toxin. Another result of the toxic action is seen in the increased excretion of nitrogen in the *urine.* The urinary secretion is diminished in amount, except during the initial stage of the fever; the colour is darker, the specific gravity is higher than that of normal urine, and urates are present in excess. The total amount of nitrogen excreted in the urine is increased, but except that the ammonia compounds may constitute ten to twelve per cent of the total nitrogen, instead of the normal two to five per cent, the distribution of nitrogen remains the same as in health, so that on examination of the urine it will be found that there is increased excretion of urea, uric acid, and kreatinin.

The urine frequently contains proteids. Serum albumin, together with serum globulin, is most frequently present; albumose is also not infrequent. The passage of these proteids through the glomeruli is almost certainly dependent on a morbid condition of the glomerular epithelium even though in some cases there are no visible changes in the kidneys. Ehrlich's diazo reaction can often be obtained, and the urine contains excess of phosphoric and sulphuric acids, and may contain acetone and diacetic acid, but the chlorides are invariably reduced except in malaria, in which disease the excretion of phosphoric acid is diminished.

Circulatory Disturbances.—The heart's action is accelerated, but the increase in frequency is by no means always proportional to the pyrexia. Thus in typhoid fever the pulse may be slow and the temperature high, whereas in severe septic infection the conditions are not infrequently reversed. There is usually diminution of the blood pressure, and the pulse is dicrotic or hyperdicrotic; in other cases the blood pressure is normal or may even be increased. The circulatory disturbances are not due to the elevation of temperature alone, for in animals exposed to a high temperature both Welch and Krehl found the functional activity of the heart was normal even though there was fatty degeneration of the cardiac muscle.

Respiration is also accelerated. This change may be artificially induced by raising the temperature of the blood, or by exposing the skin to heat. But in fever marked increase of the respiratory frequency is usually dependent on indirect causes, such as cardiac enfeeblement, or inflammatory changes in some part of the respiratory tract.

Digestive Disturbances.—The salivary and gastric secretions are deficient, and the absorptive power of the stomach is diminished. There is consequently interference with the patient's appetite and digestion. Intestinal peristalsis is lessened, the hepatic cells show degenerative changes, and there is interference with the conversion of ammonium carbonate into urea, and the secretion of bile is diminished.

Cerebral phenomena—headache, inability for mental work, delirium, stupor, and coma—all due to the action of the toxins on the central nervous system, are usually well marked in fever, whereas in simple hyperthermia these phenomena are conspicuous by their absence.

Treatment of Fever.—In every case the endeavour must, if possible, be made to treat the fever specifically, but in only a few febrile diseases has this aim been hitherto attained. The patient must be carefully watched and nursed, and the diet must be light and such as can be easily assimilated. In the event of specific antitoxic treatment being impossible, the question arises as to whether the pyrexia should be treated, and if so in what manner should treatment be carried out. The view which probably at present finds most general acceptance is that pyrexia should be dealt with when it attains an excessive height, or when it has persisted, or is likely to persist, for a protracted period, but that moderate pyrexia should not receive special treatment. The drugs of the antipyretic group reduce the pyrexial temperature to normal, yet the mode of action of many of these substances is imperfectly understood. It may, however, be stated that they may act (1) by diminishing oxidation; (2) by inducing diaphoresis; (3) by destroying the causal virus or rendering its toxic product innocuous. The most efficient antipyretics are antipyrine, antifebrin, quinine, phenacetin, salicin and its compounds, aspirin, etc. Most of these drugs have a markedly depressing effect, particularly on the heart, and may induce collapse, cyanosis, fall of blood pressure, and other unfavourable symptoms. Antipyretics should therefore be employed with caution, more especially as they have no curative action, and do not shorten the duration of the disease. The employment of antipyretics is indeed less relied on now than formerly.

Diaphoresis is often beneficial in fever; it may conveniently be induced by means of the hot pack. In the application of cold to the surface of the body one possesses a reliable and safe method of lessening pyrexia. One may make use of the cold bath (temperature of 90° F. cooled down to about 70° F.), or the cold pack, or one may rub the patient with ice, or sponge with cold or tepid water. The bath or cold pack combined with ice rubbing is the best means of treating hyperpyrexia, in which condition the free administration of alcohol is servicable. For further information regarding the cold pack, baths, etc., *vide* the articles Balneology, vol. i., and Hydropathy, vol. v.

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Tendon-Jerks.—*Nature of the Tendon-jerks.*—The tendon-jerks, tendon phenomena, or tendon reflexes, as they are sometimes called, first attracted attention through the writings of Erb and Westphal.

There has been much discussion regarding their nature. Some writers have held that they are true reflexes, while others have opposed this view, believing that they are due to direct stimulation of the muscles by vibrations transmitted from the tendons.

In considering this question it is convenient to take the knee-jerk as a type.

The observation that the time reaction of the knee-jerk is very much shorter than that of a true reflex has been repeatedly confirmed. Further, it has been shown that if the nerves connected with the patella tendon are divided the knee-jerk is not abolished.

For these reasons it is difficult to believe that the knee-jerk is a true reflex.

If, however, the posterior roots in the lumbar region of the spinal cord are divided in an animal, or diseased in man, as is often the case, for instance, in tabes dorsalis, the knee-jerk is found to be absent. Similarly, it is lost if the lumbar segments of the spinal cord, or the anterior roots which pass from them, or the peripheral nerves connected with the quadriceps muscle, are destroyed.

These facts show that the knee-jerk is dependent upon the integrity of a reflex arc, although, as we have seen, it is not a true reflex.

It is essential for the occurrence of a tendon-jerk that the muscle shall be in a state of slight tension which it is possible to increase by mechanical means. Thus in order to obtain the knee-jerk it is necessary to flex the knee; by this means the quadriceps is put slightly on the stretch. Further, Sir William Gowers has pointed out that although a tap on the lateral aspect of the Achillis tendon produces an Achillis-jerk, if the tendon is supported on the other side so that it cannot yield, a tap which previously caused a contraction will not now do so. This is the reason why a tendon-jerk can only be elicited in the case of certain tendons, viz. those which on account of their anatomical relations are capable of being suddenly put upon the stretch. The tendon is only of importance in so far as it allows of the tension of the muscle being suddenly increased. The proof of this is that in the case of some jerks, for example, the jaw-jerk, a tap on the bone, to which the muscle is attached, is equally effective. The jaw-jerk must be clearly distinguished from the so-called periosteal reflexes. The latter are true reflexes; unlike the tendon-jerks, their occurrence is not dependent on the sudden stretching of the muscle.

Finally, the most satisfactory explanation of the nature of the tendon-jerks assumes that the degree of tension in the muscle which is necessary before a tendon-jerk can be obtained induces reflexly in the muscle "a state of irritability to local mechanical stimulation" (Gowers), which manifests itself in a contraction when the muscle is suddenly put upon the stretch.

The activity of a tendon-jerk varies with, and serves as an indicator of, the state of the muscular tone (spinal *tonus*) in the muscle with which it is connected. Where there is a breach in the continuity of the spinal reflex arc the muscular *tonus* is diminished (hypotonia), as are the tendon-jerks. On the other hand, lesions of the cerebro-spinal motor tract are commonly associated with an increase in the muscular tone (hypertonia) and an exaggeration of the tendon-jerks.

The exaggeration of the tendon-jerks in the case of lesions affecting the pyramidal tracts points to a restraining influence normally exerted upon them through these fibres. Possibly the exaggeration may depend, as Hughlings Jackson has suggested, upon an unopposed cerebellar influx.

In cases of total transverse lesions of the spinal cord in man, as Bastian was the first to point out, the tendon-jerks below the level of the lesion are abolished. Their absence cannot be attributed to shock, for, unlike the temporary loss which occurs on the paralysed side after a sudden hemiplegia, they remain absent for many weeks or months. The lower limbs are hypotonic in these cases.

"Clonus" is a phenomenon which is often met with in pathological conditions in association with exaggeration of the tendon-jerks. Thus in certain cases where the foot is suddenly dorsiflexed and the pressure maintained, a series of contractions occur in the calf-muscle; this we term ankle clonus. The explanation of its occurrence is precisely similar to that of a simple jerk, the persistence of the stimulus inducing another contraction after each relaxation of the muscle.

It is important to distinguish the excitability of a muscle to mechanical stimulation applied directly to the muscle itself from that induced through its tendon.[1] "A muscle moves when struck because of its innate capacity to twitch when irritated, but it does not move when excited by a blow on its tendon unless it has, besides its own excitability, a constant influx of tone waves from spinal centres" (Weir Mitchell).

Pathological States of the Tendon-jerks.—The tendon-jerks are diminished or abolished in the following conditions:—

(1) Lesions of the spinal reflex arc.

(*a*) Lesions of the peripheral nerves, *e.g.* peripheral neuritis, or injury to the nerves which pass to and from the muscle.

(*b*) Lesions of the posterior roots, *e.g.* tabes dorsalis, Friedreich's ataxy, etc.

(*c*) Lesions involving the anterior horns of the spinal cord, *e.g.* myelitis, poliomyelitis anterior acuta, progressive muscular atrophy, etc.

(*d*) Primary lesions of the muscle, *e.g.* the muscular dystrophies.

(2) Total transverse lesions of the spinal cord above the level of the reflex arc, *e.g.* fracture dislocations of the spine, pressure paraplegia produced by caries or tumour (the late stages), very occasionally as a result of acute myelitis.

(3) As a temporary condition the result of shock, *e.g.* in cases of hemiplegia of sudden onset, and in paraplegias due to a spinal hæmorrhage or an acute myelitis.

(4) During sleep, in chloroform narcosis, severe asphyxia, and coma.

(5) Occasionally in lesions of the cerebrum and cerebellum, especially tumours (probably in some cases this is accounted for by a degeneration of the spinal posterior roots).

The tendon-jerks are increased as a consequence of—

(1) Irritation of the spinal reflex arc produced by strychnine and absinthe, tetanus, the early stages of peripheral neuritis (?).

(2) Lesions of the cerebro-spinal motor tracts.

(*a*) Primary degeneration of the pyramidal tracts, *e.g.* general paralysis, amyotrophic lateral sclerosis.

(*b*) Degeneration of the pyramidal tracts secondary to a transverse lesion of the spinal cord, *e.g.* myelitis, disseminated sclerosis, spinal tumours, pressure paraplegias, etc. Déjerine has pointed out that the tendon-jerks are increased above as well as below the level of the lesion, in some cases of local disease of the spinal cord.

(*c*) Cerebral lesions, *e.g.* hemiplegia produced by hæmorrhage, embolism, thrombosis, tumours, etc. The tendon-jerks are increased, on the opposite side of the body, also to a less extent on the same side, as Brissaud was the first to point out.

(3) As a temporary state after an epileptic convulsion.

(4) Hysteria, neurasthenia, and asthenic states following upon long-continued fevers, etc.

(5) During light sleep and in the early stages of asphyxia.

The examination of the tendon-jerks often affords most valuable information as to exact localisation in diseases of the spinal cord.

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[1] In cases of tabes, for instance, where the knee-jerk is absent and the quadriceps muscle hypotonic, the visible contraction of the quadriceps in response to direct percussion is often markedly increased, a point to which attention was drawn by T. Buzzard many years ago.

The Examination of the Tendon-jerks.—Before describing the methods best adapted for the examination of the individual jerks, it will be convenient, in order to avoid repetition, to emphasise certain precautions which demand attention in the case of all.

Firstly, Thoroughly relax the limb.

Secondly, Look for the contraction in the muscle, for the movement of the limb affords only a rough indication.

Thirdly, In comparing the jerks of opposite sides always make the examination with exactly similar precautions.

Fourthly, Never conclude that a jerk is absent before "reinforcement" has been tried.

The following are the means of reinforcement—the importance of which was first indicated by Jendrassik—which are most convenient for clinical purposes:—

Ask the patient to clasp his hands and pull strongly, keeping his eyes at the same time fixed upon the ceiling. If in this way the limb is not perfectly relaxed, ask him to count aloud up to a hundred, or engage him in conversation in order to withdraw his attention from the operation. A *sudden* pull on the hands is sometimes found to be of value as an aid in eliciting the jerk, the tendon being struck a second or two later.

The following are the tendon-jerks which are of chief clinical importance—

(*a*) Jaw-jerk, (*b*) biceps-jerk, (*c*) triceps-jerk, (*d*) wrist-jerk, (*e*) knee-jerk and knee clonus, (*f*) adductor-jerk, (*g*) Achillis-jerk, (*h*) ankle clonus.

We shall now consider them individually, the method of examination to be used in the case of each, and the constancy of each jerk in health.

Jaw-jerk.—Ask the patient to partially open his mouth as if about to yawn. The physician places the index finger of his left hand across the chin and taps it with a percussion hammer or with the finger of his right hand. If the jerk is well marked there is a sudden upward movement of the jaw.

Another good method is to rest a tongue-depressor on the teeth of the lower jaw and percuss upon it.

The jaw-jerk, although, etymologically speaking, not a tendon-jerk, is of a precisely similar nature, the tension of the muscle being increased by a tap upon the bone to which it is attached.

This jerk is not constantly present in health, and its absence is not therefore of significance, unless in association with other symptoms which would lead one to expect an exaggeration.

The jaw-jerk may be increased in the conditions already referred to (p. 125). A clonus is sometimes obtained in cases of pseudo-bulbar paralysis, etc.

Biceps-jerk (C. 5-6).—Flex the patient's arm slightly, grasp it above the elbow, placing the thumb of the left hand on the biceps tendon just above the joint. Allow the patient's hand to rest against your chest, his elbow being flexed to rather more than a right-angle. With the percussion hammer, which it is necessary to use for this jerk, strike the thumb which is resting on the biceps tendon and look for a contraction in that muscle. This method the writer first learned from James Collier.

Triceps-jerk (cervical segments, 6-7).—Take hold of the patient's arm by its anterior aspect, just above the elbow. Allow the fore-arm to hang dependent, and strike the triceps tendon close to its insertion into the olecranon.

A percussion hammer should be used in examining this jerk; a stethoscope with a rubber ring round the ear-piece will be found a convenient instrument for the purpose.

Wrist-jerk (C. 7-8).—The patient flexes his arm to a right-angle, keeping the elbow close to the side and the forearm in a position of semi-pronation. The observer grasps the wrist by its ulnar aspect and strikes the radius just above the wrist; if the jerk is present the tap will be followed by a movement in the direction of flexion.

The arm-jerks above described are usually to be obtained when correctly tested. Sometimes, however, even the most careful examination fails to elicit them in a healthy individual. For this reason their absence is less significant than absence of the jerks in the lower extremities. Unilateral absence or a very obvious difference on opposite sides of the body is to be regarded as of diagnostic importance.

Occasionally in cases of cerebral disease a triceps clonus may be obtained. In some cases of rigid hemiplegia, where there is marked contracture of the fingers, a sudden and maintained extension of the fingers will produce a wrist clonus.

Knee-jerk (L. 2-4).—There are several ways of testing this jerk. That most generally employed is to tap the patella tendon while the patient is sitting with one leg crossed over the other, repeating the process in the case of the opposite leg. Or the patient may sit on a table with his legs dependent; this is a useful method for comparing the activity of the two jerks, especially in a case where there is difficulty in relaxing the hamstrings when examined in the ordinary way.

A very useful plan is as follows:—The patient sitting on a low chair extends both his legs as far as possible, keeping the soles of the feet and heels in contact with the ground. The slightest contraction of the quadriceps in this position produces a forward movement of the foot.

Where the patient is to be examined in bed, the best means of obtaining the jerk is to ask him to turn slightly on the side to be examined, and to flex the leg at the knee (in this position complete relaxation is best obtained); then raise the limb slightly from the bed, supporting it from below with one hand below the knee, and strike the tendon, watching the vastus internus muscle for any contraction which may occur in it.

In comparing the activity of the knee-jerks on opposite sides where the patient is confined to bed, the following method will sometimes be found useful:—The lower limbs being extended and thoroughly relaxed, and the patient lying in the dorsal position, the index finger of the left hand is placed transversely across the limb just above the knee and in contact with the upper border of the patella. A downward stroke of the hammer on the finger is followed by a contraction of the quadriceps, drawing the patella suddenly upwards. The knee-jerk can only be obtained by this means if it is abnormally active.

In the case of children, a good plan is to take hold of the foot, allowing the sole to rest on the palm of the hand, at the same time slightly dorsiflexing the foot, the leg being flexed at the knee. When the tendon is struck any forward movement of the leg is readily felt by the hand which grasps the foot.

The ulnar aspect of the right hand makes a good percussor in the case of the knee-jerk, although some form of percussion hammer is better.

It is very important in testing the knee-jerk to look for the contraction in the vastus internus muscle. As has been already stated, the leg is only the lever which expresses the contraction in the muscle. Where the patient is wearing boots, or in the case of stout people (where the lever is a heavy one), there may be no movement of the leg, although there is a fairly good contraction of the muscle.

Knee clonus is to be tested for by suddenly depressing the patella tendon, when a series of clonic movements occur.

The knee-jerk is constantly present in health, and is equally active on the two sides. Considerable variations in its activity are to be found in different individuals.

Absence of the knee-jerk is always indicative of organic disease; it is never absent in a purely functional disorder. The alterations which it undergoes under various conditions have been already stated (p. 125). Knee clonus, like ankle clonus, is almost always a sign of organic disease.

A crossed knee-jerk is very occasionally met with; it may be a true reflex; its time reaction is several times as long as the uncrossed.

Adductor-jerk (L. 4 [?]).—This is best elicited by abducting the thigh and tapping the tendon of the adductor-magnus or the internal condyle of the femur. A contraction of the adductors results.

This jerk is only present in a minority of healthy individuals, but can usually be obtained when the other tendon-jerks in the lower extremities are increased.

The crossed adductor-jerk, like the crossed knee-jerk, is probably a true reflex.

Tendo-Achillis-jerk (L. 5-S. 1).—The patient kneels on a chair, and the tendo-Achillis is struck with the hammer just above its insertion. A sudden plantar movement of the foot follows the stroke on the tendon.

If the patient is confined to bed, ask him to turn on the side to be examined and to flex the knee, allowing the limb to rest on its outer side on the bed. Take hold of the toes in the fingers of one hand and with the hammer tap the side of the tendon.

Ankle clonus (L. 5-S. 1) is best obtained by flexing the limb at the knee, and suddenly dorsiflexing the foot; when the pressure against the sole is maintained a clonus is set up in the calf-muscles.

Where the clonus is well marked it continues so long as the pressure is maintained (persistent clonus); it may cease, however, after a few movements (imperfect ankle clonus).

The Achillis-jerk is constantly present in health in children, and adults up to fifty years of age. Its absence affords definite evidence of organic disease, for it is never lost as a result of hysteria or functional conditions.

Absence of the Achillis-jerk is of especial importance for diagnosis in cases where the knee-jerk is unaltered. Thus in some cases of tabes, and occasionally in peripheral neuritis, it may be lost while the knee-jerks are still present. After syphilis it is sometimes absent, the knee-jerk being normal, and it is usually absent on the affected side in a case of sciatic neuritis.

True ankle clonus is never present in health. It has been stated by some authorities that it never occurs in hysteria. Although it is true that the pseudo-clonus of hysteria can often be distinguished from that of organic disease, the fact remains that in some cases in which everything points to functional disease alone, an ankle clonus occurs which it is impossible to differentiate from that of organic disease. The pseudo-clonus of hysteria is commonly more irregular and often faster than that of true clonus. Dr. Charles Beevor points out that in cases of false clonus, if the foot is very slowly dorsiflexed, before it reaches the point of maximum dorsiflexion, a plantar movement of the foot on the part of the patient usually starts a clonus, whereas in true clonus a sudden movement of dorsiflexion on the part of the observer is necessary to produce it.

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Teratology.

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Definition.—Teratology is the science which deals with antenatal malformations and monstrosities (*terata*), and it forms the better known part of the large subject of Antenatal Pathology. With the other and less known part the author has already dealt ("Intra-Uterine Diseases and Death of the Fœtus," vol. x. pp. 21-36). Further, certain portions and some aspects of teratology have been considered under other headings, *e.g.* under "Deformities" (vol. ii.), "Heredity" (vol. iv.), "Hermaphroditism" (vol. iv.), "Labour" (vol. vi.), "Maternal Impressions" (vol. vii.), "Pregnancy, Multiple" (vol. ix.), and "Spina bifida" (vol. xi.); and the description of the diseases of several organs and parts of the body has occasionally included references to their malformations (*vide* "Bladder," "Brain," "Cheek," "Chest," "Colon," "Diaphragm," "Ear," "Eyelids," "Generative Organs," "Heart," "Intestines," "Iris," "Mouth," etc.) In this article, therefore, the author deals only with the general principles of teratology, with teratogenesis or the causation of monstrosities, and with such individual types of monstrosity as have not been referred to elsewhere.

General Principles.—Monstrosities and malformations are produced at an earlier date in antenatal life than congenital diseases; the former occur when the new organism is still in the embryonic phase, while the latter arise in the fœtal stage. Teratology, in a word, is embryology in disorder; monstrosities and malformations are the results of disturbances in the normal organogenesis of the individual before birth; there is defective ontogeny; the vital dynamics of the antenatal formative processes are under the influence of morbid agencies.

Teratology being then the pathology of the embryo, it of necessity follows that a knowledge of the physiology of the embryo must precede the inquiry into its pathology, for the physiology of any part of the life of the individual gives a special character to its pathological manifestations. Now the physiology of the embryo differs markedly from, say, the physiology of the fœtus; almost the sole function of the embryo is to form its parts and organs, it is constructive; on the other hand, the fœtus has functions which resemble in the main those which are found after birth, and the chief result of the right performance of the fœtal functions is growth of tissues and organs as distinguished from differentiation of tissues and organs. The physiology of the embryo is embryology, or rather the anatomy and physiology of the embryo are inseparably bound up together in embryology. For the proper understanding of teratology, therefore, it is necessary to have a good working knowledge of embryology. Unfortunately, a good working knowledge of embryology is not at present obtainable; there are, as regards the human embryo at least, many points in its construction over which darkness rests, and there are lacunæ in our information, more especially of the earliest phases of embryogenesis, which cannot yet be filled up. There is little wonder, therefore, that teratology has many vexed questions and many unsettled problems. Since we cannot yet tell precisely how the embryo *forms* in the womb it is not surprising that we cannot understand exactly by what means it is sometimes *malformed.* Such knowledge, however, as we possess is of value, and the reader will do well at this point to peruse or reperuse the article on the DEVELOPMENT OF "FŒTUS AND OVUM" (vol. iii.)

The first factor which gives to teratological phenomena some of their most striking and puzzling characters is, therefore, the embryological one; in embryology rightly understood is the solution to many of the problems of teratology. Let us consider one or two instances of this. Not the least striking feature of embryological processes is their complexity; the whole progress of the development of the embryo is from the simple towards the complex, from the general towards the specialised. In this ontogenetic progress, however, the elaboration and specialisation is not continuous, but interrupted. Apparently the framework of the body is not laid down once for all, but is rather constructed in portions, and even in overlapping portions, so to speak. One part of the framework may be replaced in whole or in part by a new substructure often of a type quite different from that which has preceded it. Readjustment, adaptation, alteration, and variation are processes constantly at work in the life of the human embryo; it is by reorganisation that order is brought out of the seeming chaos of blastodermic activity. Temporary scaffoldings are, as it were, raised in order that the whole building of the embryonic cosmos may grow up symmetrically and in such a manner as permits of the later introduction of new structural features; and one of the most beautiful adaptations in organogenesis is that by which the materials of these temporary scaffoldings are utilised and worked into the completed organism. Only here and there in the body, as for example in the appendix vermiformis, do we see traces of these scaffoldings which have not been entirely built into the permanent structure. This conception of embryological processes makes it easier to understand teratological phenomena, for many monstrosities are evidently arrested developments; they represent stages in organogenesis which are usually transitory, but which under certain circumstances are rendered permanent. The formation of one part of the body may be arrested while that of the rest of the body goes on to its full completion, and so a malformation of a part may be met with while the other portions of the organism are well constructed. If we could obtain a cinematographic representation of ontogeny then we could recognise when and in what part of the living picture the process of arrestment took place.

A second factor which has to be kept in mind in endeavouring to understand the phenomena of teratology is found in the immediate environment of the embryo during the developmental processes. In the earliest phases the amniotic membrane comes into close contact with the new organism, and later the liquor amnii takes its place and constitutes the embryonic hydrosphere. There is much to show that this amniotic environment plays an important part in determining the nature of the pathological manifestations of embryonic life, and it cannot be doubted that it is instrumental in producing a great many of the arrests which lead to malformations and monstrosities. If there is one thing which experimental teratogenesis has shown, it is that amniotic adhesions and pressure are agents in the disturbance of normal ontogeny.

A third factor is the germinal one. All teratological phenomena do not arise in the embryonic epoch of antenatal life; some are determined already in the germinal period. It is scarcely conceivable that hereditary malformations, and there are many instances of such, can owe their origin to causes coming into play after the laying down of the first rudiments in the embryonic area of the blastoderm; their hereditary nature practically implies that they were determined before that time. Again, there is some reason to believe that double monstrosities arise in the pre-embryonic epoch, and that they are caused by anomalies in the phenomenon of ovum-penetration by the spermatozoa or by disturbances in the extrusion of the polar bodies.

That these three factors, and possibly others, are effective in influencing the production of pathological processes in the embryo is without doubt, that a knowledge of them is of value in understanding these pathological occurrences is also without doubt; but, unfortunately for the successful explanation of teratological phenomena, these factors are themselves little understood. There are many difficulties in embryology; the development of the human amnion is still a mystery; and what happens in the pre-embryonic or germinal period of antenatal existence is concealed by nature's veil. At the same time the information which we possess is of great value, and with each advance in our knowledge of normal embryogenesis will come a surer appreciation of the facts of pathological development. Teratology is the pathology of the embryo as influenced by that of the germ; teratogenesis is morbid embryogenesis.

Causation of Monstrosities (Teratogenesis).—There is scarcely any part of the history of medicine which has a more interesting past than that of the theories of the production of malformations and monstrosities. The modern scientific investigator pauses in dismay and humiliation when he is brought face to face with the teratogenetic theories with which former generations of medical observers were content, and his feelings are little altered when he realises how much of the past is contained in the accepted doctrines of the present day. This article is hardly the place to consider the theories of the past in so far as they refer to teratogenesis; but a very few words may be devoted to the enumeration of two or three of the more noteworthy of them.

Perhaps the best known of these *theories of the past* is that which ascribes the various malformations of the fœtus to the imagination of the mother during pregnancy. This subject has been already considered by the writer ("Maternal Impressions," vol. vii.), and need not be again referred to except to point out that it is far from being discredited by all obstetricians, although of scientific proof it is sadly lacking. Another group of the teratogenic theories of the past contains the supernatural explanations which were given by the ancients to explain malformed infants, and which are still accepted by primitive peoples at present inhabiting various parts of the world. According to some of these views the gods made monstrosities to amuse themselves and to astonish mortals, or to warn the inhabitants of the earth of impending calamities; these ideas are wrapt up etymologically in the words "monster," "freak of nature," "portent," etc. According to other views it was to the evil deities only that men were indebted for the appearance of monstrosities upon the earth; and in Christian times it soon came about that Satan was connected with teratological phenomena, a belief of which abundant traces are to be found in the witchcraft trials of the Middle Ages. According to yet other views monstrosities were caused by peculiar conjunctions of the heavenly bodies, and a whole mass of astrological beliefs arose concerning stellar influence in teratogenesis. The moon also was supposed to have a maleficent effect upon the unborn infant, as is shown by the occurrence of the word "moon-calf" as a synonym for a monster, mole, or false conception.

A third group of the theories of the past looked to purely physical agencies for the causes of monstrous births. In those early times it was thought that the male semen and the menstrual fluid of the mother together made up the new organism. Consequently it was a natural enough conclusion that defects in the male and female generative elements would result in the production of malformations and monstrosities. The teratological manifestations which showed defective formations, such as brainless infants and fœtuses without eyes or limbs, were put down naturally enough to too little semen or too little menstrual discharge, while the double monsters and united twins were ascribed to too much. Other developments followed: it was believed that the admixture of the generative elements in abnormal proportions or in morbid states would prove teratogenic; and, finally, it was accepted that the mixture of the seed of animals of different species would assuredly lead to the birth of all kinds of grotesque and unnatural hybrid-forms. Had the ancients, *e.g.* Aristotle, possessed more correct notions of the real nature of impregnation it cannot be doubted that their theories of teratogenesis would not have differed so markedly from those now in vogue as they apparently do; indeed, some modern views do not really differ much from the notions of too much and too little semen which were enunciated so long ago.

The *teratogenetic theories of the present* may be divided into three groups according as the causal factor invoked is mechanical, pathological, or embryological. It is necessary to devote a few lines to the consideration of each of these groups.

The idea that fœtal deformities may be due to *mechanical causes*, although truly modern in its full development, was present in the mind of Hippocrates when he wrote, in his *De Genitura*, about infants crippled in the womb on account of narrowness of a part of it; and Aristotle had evidently some notion of it when he explained double monsters in animals by the fusion of two contiguous vitelli. Many centuries later Paré also referred to malformations produced by the straitness of the womb, and evidently thought that external pressure applied to the abdomen might likewise have a teratogenic effect. In modern times these theories appear under new names, but differ little in reality, and they may be grouped as follows:—

Mechanical or Pressure Theories of Teratogenesis.—1. External pressure. (*a*) General maternal traumatism, *e.g.* falls and blows. (*b*) Injuries and pressure affecting the maternal abdomen, *e.g.* corsets. 2. Internal pressure. (*a*) Intra-abdominal, *e.g.* from abdominal tumours, pelvic contraction, and narrowness or malformation of the uterus. (*b*) Intra-uterine, *e.g.* from uterine tumours, a twin fœtus, a fœtal limb, the umbilical cord, the amnion or amniotic adhesions.

In the minds of most teratologists there may exist some doubt about the teratogenic power of external pressure, but internal pressure of the kinds referred to in the above classification is generally accepted rightly or wrongly as a potent agent in producing monstrosities. Coiling of the umbilical cord round one or several limbs of the fœtus has been freely accepted as a cause of the curious spontaneous amputations which are sometimes seen at birth; it is certainly often associated with the occurrence of grooves and sulci on the limbs and digits. The most popular of the pressure theories of the present day is that which looks to the amnion as the immediate cause of monstrous productions. Experiments in comparative teratogenesis by Dareste and others have shown that in the case of the chick, at least, non-development of the amnion very often exists along with various monstrosities; and in anencephaly and sympodia, for instance, it is a satisfactory hypothesis to regard the malformations of the head and pelvis as caused by non-separation of the amniotic membrane in these regions. By inference the non-separation will cause pressure on the underlying part. As will be seen later, this view takes its place in the embryological theory of origin of monstrosities.

The second modern theory may be called the *pathological*, for it looks to diseases of the fœtus for the causal factor in teratogenesis. This idea was first strongly advocated by Marcot and Morgagni in the eighteenth century, although indications of it are to be found in the work of Licetus published in the preceding century. The various forms of defective ossification of the bones of the head were ascribed to inflammatory conditions of the cerebral ventricles which led to hydrocephalic states, and these in their turn to defects in the cranium; when the hydrocephalus was very great, rupture of the cranial vault might occur, and thus anencephaly be produced. In a similar way exomphalos was supposed to be due to the accumulation of a large quantity of fluid in the abdomen and the giving way of the anterior abdominal wall; spina bifida by an accumulation of cerebro-spinal fluid in the spinal canal; cyclopia from the dropsical destruction of the bones of the nose; extroversio vesicæ by the overdistension of the urinary bladder; and intestinal malformations by fœtal peritonitis. It cannot be said that this manner of looking upon teratological productions is in keeping with the most recent view of embryology and ontogenesis; for it is well known that the time when monstrosities are produced antedates that when diseases arise; and, therefore, it can hardly be maintained that the fœtal diseases are the causes of the embryonic malformations. At the same time it cannot be doubted that diseases coming on in fœtal life may have their manifestations altered by pre-existing malformations, and that, conversely, pre-existing malformations may be modified by later developed maladies. To this extent there is evidence in support of the pathological theory of teratogenesis.

The third of the modern theories of teratogenesis may be termed the *embryological*, for it finds in an interference with the normal processes of embryogenesis the true explanation of teratological developments. Its distinguishing feature is the assertion that monstrosities are due, not to special causes, but to the causes of disease acting upon the embryonic organism. It is not that fœtal diseases give rise to monstrosities, it is that the causes of fœtal as well as adult diseases give rise when acting upon the embryo to embryonic malformations, and the embryonic malformations are the monstrosities. The proof of this conclusion lies mainly in the experimental work of Dareste and Féré, who have shown that by altering the incubation-conditions it is possible artificially to produce deformed chicks. Féré, further, has demonstrated that by injecting toxic substances, germs, and toxines into the albumen of the hen's egg in the early stages of development, it is possible to cause maldevelopments and non-developments; that is to say, by bringing the ordinary causes of adult disease to bear upon the embryonic organism, monstrosities and not diseases result. The same thing has been shown with regard to many of the invertebrates, but the experiments upon the chick are naturally of more value in enabling us to draw conclusions regarding the human embryo. At the same time, it is necessary to remember that it is not safe to expect that the details in the production of mammalian malformations will be the same as those which come into play in the origin of avian monstrosities; avian and mammalian embryology differ, and it is reasonable to expect that avian and mammalian teratogenesis will also differ, not perhaps in general principles, but certainly in details. It is particularly interesting to note that experiment has shown that just as the alcohols and aldehydes differ in their toxic powers, so also they vary in their teratogenic potency; further, the more toxic the alcohol is, the more capable it appears to be of producing monstrosities in the chick. This theory of teratogenesis receives a certain measure of support from the clinical histories of the parents of monstrous infants, for it is not uncommon to find that the mother (or the father) has been a sufferer from tubercle, syphilis, alcoholism, an eruptive fever, or lead-poisoning during or before the pregnancy; the conclusion is that the poison or toxine has interfered with the normal processes of development.

The manner in which the toxine, germ, or poison acts upon the embryo has not yet been fully ascertained; but some conclusions seem fairly to be warranted. It would seem, for instance, that the morbid cause very often acts by arresting normal embryogenesis. When the arrest is complete the result is a non-development; when it is partial, one organ or part of the body alone shows delay, the rest of the organism goes on developing around it, and the result is a monster. In this way most of the monstrosities by defect are probably produced. With regard to the double monsters (united twins) and monstrosities by excess, it would seem that the morbid agency comes into play at an earlier than the embryonic period; it is a fairly probably hypothesis that it alters the chemistry of the ovum, or its immediate environment, and thus permits the passage of two spermatozoa through the vitelline membrane. Polyspermy thus produced would then be the cause of the development of two embryonic areas, and according as these lay separate or in contact, and were complete or incomplete, there would result normal twins or double monsters, or monsters by excess (accessory limbs, parasitic fœtuses, etc.) Another teratogenetic method would seem to be that by inclusion (“*enclavement*”), by which it is meant that a whole fœtus (more or less defective) is included within its twin brother or sister, or that, in the case of a single fœtus, a part of its ectoderm becomes displaced inwards, and lies and undergoes some further development among the ectodermal and mesodermal tissues. Now and again, also, it would seem as if embryological phases which are normal in the development of certain animals, but which do not, as a rule, show themselves in human organogenesis, appear in the latter, and so lead to atavic manifestations. Of course, it must be borne in mind that there is much obscurity in all these matters, and that many of the statements which are to be found in works on teratology are really hypothetical.

It is safe to conclude that malformations and monstrosities, as a rule, represent faults in nutrition induced by one or other of the recognised causes of disease. Nutrition in the embryonic period of life results, of course, in development rather than in growth, and consequently defective nutrition will then interfere with development and produce maldevelopment. There will be an arrest of the formative processes in whole or more commonly in part,—structures which ought to appear will not do so, structures which ought to unite will remain separate, phases which ought to be temporary will be permanent,—and so various malformations and monstrosities will be produced. It is comparatively easy, further, to understand how defective development of the amnion will, by preventing the peripheral expansion of the underlying parts, lead to many of the well-known teratological manifestations, such as anencephaly, sympodia, exomphalos, etc.

Classification.—Hitherto teratological classifications have often been rather a hindrance than a help to the understanding of the subject. There have been many of them, the names employed in them have been polysyllabic and unfamiliar, and different teratologists have employed very different methods with widely different results. One of the simplest, as it is also one of the oldest methods of classification, is to divide all monstrosities into those by excess, those by defect, and those in which there is altered relation of parts. After all that has of late years been discovered, this method has still much to recommend it. The method adopted by the writer (in *Teratologia*) is a modification of that used by the late Professor Taruffi of Bologna, and aims at being both simple and yet sufficiently comprehensive to find a place for all known malformations. By it monstrosities are divided into two primary divisions according as they represent two fœtuses or only one, the polysomatous and the monosomatous terata. The monosomatous terata, again, are subdivided into those in which the whole body or at least several parts of it are malformed, and those in which only one part or region is deformed; for the latter a strictly regional classification is adopted. Finally, a separate place is found for the curious cases of inversion of the viscera or heterotaxy. In an abridged form the scheme is as follows:—

A. Polysomatous Terata—
  1. Monochorionic or uniovular twins.
  2. Allantoido-angiopagous twins or placental parasites.
  3. United twins or double terata proper.
    (*a*) Symmetrically united.
      (1) Syncephalus.
      (2) Dicephalus.
      (3) Thoracopagus.
    (*b*) Asymmetrically united or parasitic twins.
  4. Triplets, etc
B. Monosomatous Terata—
  1. Whole body (or several parts of it) malformed (pantosomatous).
  2. Parts of the body malformed (merosomatous).
    (*a*) Head.
    (*b*) Neck.
    (*c*) Thorax.
    (*d*) Abdomen and pelvis.
    (*e*) Spine.
    (*f*) Limbs.
  3. Heterotaxy or transposition of the viscera.

In this classification the first section roughly corresponds to the monstrosities "by excess" of the older schemes, while the second includes the malformations "by defect" and by "altered relations."

Types of Terata.—As it is impossible within the limits of an article such as this to describe or indeed name all the varieties of teratological development which may be met with, the writer contents himself with referring to the outstanding types.

Types of Polysomatous Terata.—Since monochorionic or uniovular twins have been already considered under another heading (Pregnancy), and since some hesitation may be felt regarding the wisdom of terming this variety of twins teratological, the writer passes at once to the consideration of the placental parasites about whose teratological nature there can be no possibility of doubt.

Placental Parasites or allantoido-angiopagous twins.—These are twins of the same sex enclosed within a single chorion, one of which shows more or less grave developmental defects, and communicates with the other by means of the vessels of the umbilical cord in the neighbourhood of the placenta. The usual clinical history in such cases is that the pregnancy terminated somewhat prematurely in the birth of a normal fœtus, but that before or along with the expulsion of the placenta a deformed twin was born; the placenta was single, and gave origin to two umbilical cords whose vessels inosculated in the substance of the afterbirth. The deformed twin may show a great variety of defects, among which absence of the heart is not uncommon; indeed, such fœtuses may be divided into the acardiac and the cardiac varieties. But a more useful classification is to group them into (1) those in which the head, trunk, and lower limbs are present, but the head is deformed, and the upper limbs very rudimentary (*paracephalic*); (2) those in which the head is entirely absent, and in which the trunk and upper limbs are very defective (*acephalic*); and (3) those in which the external appearances of a fœtus are lost, and a rounded mass with slight indications of limbs and sense organs is all that is to be seen (*amorphic, anidean*). The internal malformations are of the most varied type; sometimes almost all the viscera are present, but in a more or less anomalous state; at other times scarcely a single part may be found, and the fœtus be represented by some fragments of bone, a loop or two of intestine, much œdematous adipose tissue, and skin. Most of these curious monstrosities are quite incapable of existence after birth; indeed the fact that they are able to reach the end of intra-uterine life is due to the communication existing between their umbilical vessels and those of the normal twin. The theories which have been advanced to explain their origin are not satisfactory. The more generally accepted view is that of Claudius as modified by Ahlfeld, according to which the twins are uniovular, and one gets the start of the other in development, and preoccupies all the available chorionic space with its vessels, so that no room is left for the vessels of the second, which in consequence becomes a parasite on the first, and has its embryogenetic processes much retarded. Another theory is that there is a primary defect of development of one of the twins, so great that if it were not for the fact that it establishes a connection with the placenta of its co-twin, it would never be able to develop even so far as it does. The writer inclines to the second view. There seems to be no doubt that the circulation is reversed in the malformed twin, and that the heart of the normal fœtus usually does double duty in driving the blood through both twins.

United Twins or Double Monsters.—Most of the polysomatous terata belong to this group. Some of them are quite evidently double, two complete fœtuses being united together by a more or less broad band of connection; in others the duplicity apparently affects only a part of monstrosity, as in the cases of a single head and two bodies, or a single body and two heads; in both these groups of terata the union is practically *symmetrical*. In another variety, however, the union is *asymmetrical*, there being one fairly well formed twin with a more or less rudimentary one attached to its body or embedded in its substance; the former fœtus is called the autosite and the latter the parasite.

Syncephalic Double Terata.—The first group of the symmetrically united twins contains those in which the cephalic ends are more or less closely joined, while the bodies are more or less separate. There are, for instance, the cases in which two well-formed twins are joined by their crania (craniopagus); sometimes the union is in the region of the vertex, sometimes in that of the forehead, and sometimes in that of the occiput. The general rule is followed that like parts are joined to like. The union in such cases is sometimes relatively superficial; the cranial vault-bones may be fused, but the brains are usually separate. Again, there are the cases of syncephalus, in which the two heads are more or less intimately fused together, and in which there may be two complete faces or two incomplete faces (two mouths, two noses, three orbits, and two ears). To these the name of Janus monstrosity is not uncommonly given, for a reason which is evident. The thoraces may be also more or less fused together. When there are two complete faces, each face may represent not that of one twin, but the halves of the two belonging to the two twins, which are so perfectly joined as to show no sign of original separation. Yet again, there are those syncephalic double monsters in which the fusion of the heads and bodies is so complete that only in the pelvic organs and lower limbs is duplicity evident (syncephalus dilecanus); these are very rare in the human subject, being represented chiefly by the cases of diphallus (double penis).

Dicephalic Double Terata.—In the second group of the symmetrically united twins the union chiefly involves the pelvic ends of the fœtuses. Here also there are different grades of union. There are, for instance, the cases in which the pelves are closely joined and the four lower limbs retained (pygopagus and ischiopagus); there are those in which not only the pelves, but also parts of the trunks are united with four, three, or two lower limbs, and four, three, or two upper limbs; and there are those in which there is such a degree of fusion that only the heads and sometimes also the necks show duplicity, the body and limbs being those apparently of one fœtus.

Thoracopagous Double Terata.—To this section belong some of the best known examples of united twins, such as the Siamese twin-brothers, the sisters Radica-Doodica (operated on by Doyen), and the sisters Maria-Rosalina of Brazil (operated on by Chapot-Prévost). The union is by means of a more or less extensive part of the anterior aspect of the thoraces and abdomens. The name xiphopagus may be reserved for those which are joined by the epigastric region and by the lower end of the sternums, while that of sternopagus may be given to those in which the whole of the sternal and epigastric areas are fused. In the latter group it would seem that one of the twins always shows inversion of the viscera, and that sometimes the two hearts are separate and sometimes more or less closely united. In both groups it is common to find a prolongation of the peritoneal sacs, and sometimes a band of liver tissue in the structure connecting the two twins. The stomach and part of the intestinal canal may be single, but often the alimentary tract is double throughout. There is usually a single umbilical cord. In a rare type of sternopagus the union is more marked, with the result that the two contiguous arms are fused into one limb, which may show signs of its double origin (*e.g.* two hands or more than five fingers); when this is so the single median limb springs from the posterior aspect of the united thoraces. In a still rarer type the two contiguous limbs may be entirely aborted and the monstrosity be provided only with two upper extremities. Many interesting physiological observations have been made on united twins of the thoracopagous type, for in not a few cases these children have survived birth; it has been generally found that while they show a very considerable similarity in tastes, feelings, etc., their chief bodily functions exhibit marked independence. The surgical possibilities of these cases will be considered in a special paragraph at the end of this article.

Parasitic Twins.—The last group of the polysomatous terata contains the cases in which one well-formed twin has attached to it or imbedded in it another twin, usually of a very rudimentary type. These monstrosities may be classified after a regional plan into (1) those in which the parasite is attached to or imbedded in the head of the autosite, cephalo-parasites; (2) those in which the union is in the neighbourhood of the face or neck, prosopo- and trachelo-parasites; (3) those in which it is in the region of the thorax, thoraco-parasites; (4) those in which the parasite is abdominal in position, gastro-parasites; and (5) those in which it is pelvic, lecano-parasites. In each of these divisions there are subdivisions, according as the parasite consists of a more or less recognisable fœtus, or only of a mass of miscellaneous fœtal tissues (teratomata, teratoids, dermoids). Included among these monstrosities, therefore, are to be met the instances of epignathus (rudimentary fœtus attached to the mouth), of heteradelphus (headless fœtus attached to the front of the thorax, such as the well-known boy Laloo), of included fœtus or fœtus in fœtu (fœtus or teratoma contained in the abdominal cavity), and of sacral parasites and tripod fœtuses (more or less defective fœtuses attached to the pelvic bones of the autosite). Many of these are quite non-viable, but some others are not incompetent for a post-natal life, and have even survived to adult life (*e.g.* the man Dos Santos, the human tripod). In a few instances surgical separation or excision of the parasite has been attempted, but seldom with success.

Triple Monsters.—It is hardly necessary to do more than name triple terata here, for they are exceedingly rare. A case of tricephalic infant was reported in the year 1834; it consisted of three heads set upon two united trunks, supported by two lower limbs; there were three upper limbs and a single set of male genitals; all the heads had to be perforated in labour, and two of them amputated. It was described fully by Reina of Catania and Galvagni.

Types of Monosomatous Terata.—So numerous are the types of single monsters and malformations that only the outstanding ones can be referred to here. Some of them, such as exstrophy of the bladder, encephalocele, diaphragmatic hernia, polydactylism, anencephaly, exomphalos, spina bifida, cleft palate, hare-lip, etc., have been described under other headings.

Malformations of the Cranium and Face.—Putting on one side the anomalies of the cranial vault, of the face, of the brain, and of the special sense organs, which have been considered elsewhere, the writer must give a few words of description here to cyclops and hypoagnathy. The *cyclops* fœtus is, as the name indicates, one possessed of a single orbital cavity containing two more or less completely fused eyeballs. The composite eye is median in position, and a nasal proboscis is usually found lying above it (very rarely below it). The malformation known as cebocephalus is evidently a connecting link between the true cyclopean fœtus and the normal, for in it there is no nose and the two eyes are approximated but not fused. Cyclops may be combined with other malformations (*e.g.* anencephaly, hypoagnathus) in the same fœtus. The single eyeball may possess two corneæ, two pupils, and two lenses; or it may be an apparently perfect single eye; or it may show intermediate types. Sometimes a single orbital cavity with no trace of an eye has been observed. Cyclops is supposed to be due to an arrest in the development of the anterior cerebral vesicle, but there are many obscure points in its teratogenesis still to be investigated. A somewhat similar monstrosity is *hypoagnathus* (also called otocephaly, agnathy, and synotia); in it the lower jaw is more or less completely absent, and the external ears are approximated towards each other under the lower part of the face. The mouth may be absent or represented only by a small aperture; the tongue and hyoid bone may be absent or rudimentary; the sphenoid bone may be malformed; and the external auditory meatuses may open directly into the pharynx. As stated, it may be combined with the cyclopean anomaly. It is due to an arrested development of the first branchial arches, perhaps on account of amniotic pressure. Sometimes in the region of the face there is no trace of eyes, nose, or mouth; the monstrosity is then called *aprosopus.*

Malformations of the Spine.—In addition to the well-known spina bifida (evident or occult) this region of the body may show the curious deformity of *retroflexion.* The whole body of the fœtus may be bent sharply back upon itself, so that the occipital region of the skull may come into contact with the gluteal region, and even become united to it, so that the glutei muscles may, as it were, arise from the occiput. This retroflexion of the fœtus is often combined with defective development of the lower part of the occipital bone, when the name *iniencephaly* is sometimes given to it; it may also be combined with anencephaly, and sometimes with exomphalos. It is possibly an arrested development, for it would seem that there is a stage in early embryogenesis when the spine is thus contorted; perhaps here also amniotic pressure may be invoked. *Tailed infants* have been described; the "tail" is usually a modified spina bifida sac.

Malformations of the Thorax and Contents.—In addition to polymastia (presence of supernumerary mammæ), fissure and lordosis of the sternum, absence of the pectoral muscles, and the congenital malformations of the heart and vessels, attention must be drawn to the rare cases of *ectopia cordis* and to absence of the clavicles. When there is exomphalos it is not uncommon to find that the defect in the anterior abdominal wall affects also the thorax, and that the heart is extra-thoracic; but it is much rarer to find an open state of the anterior thoracic wall alone with protrusion of the heart. It is apparently a commoner malformation among birds than in the human subject. The parietal layer of the pericardium may be absent. Infants born with this malformation usually survive only a few hours. *Absence of the clavicle* may be unilateral or bilateral, and it may be complete or partial; this also is a very rare deformity, but unlike ectopia cordis it is quite compatible with post-natal existence.

Malformations of the Abdomen and Contents.—Most of the malformations of the abdomen have been described under other headings. They include the various types of exomphalos, of ectopia vesicæ, of horse-shoe kidney, and of intestinal anomalies. It may be noted that while defects in the anterior abdominal wall with protrusion of the viscera are commonly mesial in position, they may occasionally be lateral, and are then sometimes accompanied by absence of the lower limb of the same side. Many cases of exomphalos are complicated by the presence of amniotic adhesions, and by retroflexion of the spinal column. Malformations of the liver, gall-bladder, spleen, pancreas, etc., occur, but have not been very fully studied. Anomalies of the generative organs have been described elsewhere.

Malformations of the Limbs.—*Sympodia* is a malformation of the lower limbs which calls for a few lines of description. It consists in a rotation of the lower limbs of such a kind that the knees look backward and the popliteal spaces forwards, combined with a varying degree of fusion of the contiguous parts. The resulting monstrosity has been called sireniform or mermaid-like. There is usually absence of the generative organs and a curious fusion and rotation of the bones of the pelvis; the bladder and kidneys are also commonly wanting. There is generally only one artery in the umbilical cord, and it has been supposed that in these cases the allantoidal vessels as well as the allantoic derivatives are absent, and that the vessels in the cord represent the omphalo-mesenteric or vitelline vessels; if this be so it would appear that the placenta must be vascularised by the vitelline and not by the allantoidal vessels. More or less complete suppression of one or more of the upper and lower limbs may be met with, and constitute amely, hemimely, and ectromely; along with these may be placed the so-called spontaneous amputations of limbs, parts of limbs, and of digits. Other malformations of the extremities consist in absence of one or other of the two bones of the fore-arm and leg, anomalies which are usually associated with suppression of the corresponding digits. A few cases of double hand have been reported, in which the radius was absent and two ulnæ found in its place.

Heterotaxy or Transposition of the Viscera.—Under the name of transposition or inversion of the viscera is described an interesting anomaly, in which the organs of the right side of the body are found occupying the left side, and *vice versa.* When the abdomen and thorax are opened it is as if the observer were surveying the parts as reflected in a mirror. The heart is on the right side, the liver on the left, etc. Even in the matter of small peculiarities, as seen in the level of organs and the direction of vessels, the transposition is accurate and complete. Rarely the thoracic organs alone are transposed. The anomaly in no way interferes with life, and is usually discovered accidentally when the individual is being examined for some abdominal or chest complaint, or for life assurance, or the army. The cause of heterotaxy has been supposed to be the position which the embryo occupies on the blastodermic vesicle; it usually lies on its left side, and has the cardiac curvature normally directed, but if it be rotated so as to lie on the right side there is inversion of the heart. Some have believed that an individual with inversion of the viscera is the right-side survivor of uniovular twins, but if so the other twin would appear to have been completely absorbed. The puzzling cases of hemi-hypertrophy and hemi-atrophy may be associated in their origin with the causes that produce heterotaxy. The functions of the body are sometimes curiously affected in transposition; thus a case has been reported of labour in a woman with this anomaly, in which the fœtal head occupied the right instead of the left occipito-anterior position.

Treatment.—There are three lines along which the treatment of monstrosities may proceed: an attempt may be made to prevent their occurrence; it will be necessary to endeavour to counteract any injurious effect they may have upon the progress and safety of the confinement which they render complicated; and means ought sometimes to be taken to repair the malformations and fit the subjects of them for a useful and happy life. The second line of treatment, which may be termed the *obstetrical*, need not be referred to here, for it has already been considered under another heading ("Labour, Faults in the Passenger"). With regard to the *preventive* treatment, it cannot be claimed that much of practical importance has been yet accomplished; but if it be correct to suppose that the causes of monstrosities are no other than the causes of disease, then it follows that if the action of these upon the unborn child can be prevented the malformations and anomalies produced by them will be eliminated. The most hopeful line of possible advance in this matter will be that of treating syphilis and alcoholism in the parents before and during the progress of gestation; the shielding of pregnant women from infection of all kinds will also be a logical procedure.

Surgical Management.—The management of malformations and monstrosities after birth in the infants which survive their advent in extra-uterine surroundings has, of course, always engaged the attention of the medical man, and more especially of the surgeon. It is unnecessary in this article to describe the various operative procedures which have been devised to remedy in the most effective manner such anomalies as hare-lip, cleft palate, exstrophy of the bladder, exomphalos, encephalocele, and defective states of the limbs, for these have been dealt with by competent surgical writers; but a few lines may be devoted to the question of the propriety of operating upon united twins, a matter which has quite recently come somewhat prominently before the medical world. Attempts to separate united twins are not altogether novelties in surgical procedure. As long ago as 1690 Koenig reported a case in which the connecting band (which contained no liver tissue) between the twins was divided, and both children survived; in a similar case operated on by Boehm (1860) one child only lived. In the instance described by Biaudet and Bugnion (1881) there was a bridge of hepatic tissue, and both twins died from hæmorrhage from the liver and sepsis. Until within the past two years it cannot be said that the new resources of surgery (asepsis and perfected hæmostasis) had ever been brought into operation to enable the surgeon to overcome the undoubted difficulties and dangers of the disjunction of double monsters. Now, however, that these means are in our hands, and that Chapot-Prévost and Doyen have led the way, it will be necessary for us to revise our ideas of the feasibility of operating upon such united children, and to formulate the indications for surgical interference. There are some cases in which the fusion of the two organisms is so intimate as to preclude any hope of successful separation, *e.g.* all the syncephalic types except perhaps some of the craniopagous twins, and most of the dicephalic with the exception of some of the pygopagous varieties; on the other hand, there seems no reason why attempts to separate most of the thoracopagous double terata should not be hopefully entertained. The cases operated on by Chapot-Prévost and Doyen were both of the last-named kind. In 1900 Chapot-Prévost of Brazil separated Maria-Rosalina, then at the age of seven years; he devised a special form of operating table, which could be divided into two halves after the separation of the twins was effected, and a special means of arresting hæmorrhage from the liver, for a bridge of liver tissue was known to exist; one twin (Rosalina) survived, the other (Maria) died about a week after the operation from pleuro-pericarditis. Rosalina, it may be noted, showed transposition of the viscera (dextro-cardia). Doyen operated upon Radica-Doodica, because the Doodica had shown symptoms of abdominal tuberculosis; Radica survived. It is, therefore, evident that the technical difficulties of separating united twins can sometimes be overcome; but it cannot be said that surgeons have yet agreed as to the proper cases upon which to operate or as to the best means and methods to employ.

LITERATURE.—A great literature has grown up around teratology. The best recent works treating of the whole subject are those of Hirst and Piersol (*Human Monstrosities*), of Taruffi (*Storia della Teratologia*, in eight volumes), of Ahlfeld (*Die Missbildungen des Menschen*), and of Dareste (*La production artificielle des monstruosités*). A description of the recent attempts at the separation of the united twins will be found in Chapot-Prévost's book, *Chirurgie des Teratopages*, Paris, 1901, and in Baudouin's article in the *Revue de chirurgie*, for May 1902.

Testicle. *See* SCROTUM, vol. xi.

Tetanus.

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TETANUS (lockjaw; tétanos, Starrkrampf) is an acute specific infective disease, characterised by involuntary tonic muscular spasms, tending to become generalised, and with paroxysmal exacerbations from time to time. The specific micro-organism, the tetanus bacillus, having gained entrance to the body, elaborates a toxin of great potency, which, acting on the motor cells of the spinal cord and medulla oblongata, increases their irritability, and thereby induces the spasms. The disease is exceedingly dangerous, and not infrequently fatal.

The disease had been recognised by Hippocrates, Galen, and Celsus. Its infective character had long been recognised, and many observers, noticing the manner in which the symptoms resembled those of strychnine poisoning, had suspected that the disease was caused by a poison. But the infective nature of the disease was first definitely established by Carle and Rattone in 1884. In the same year Nicolaier discovered the tetanus bacillus in garden soil. Rosenbach in 1886 found the bacillus in the wound in a case of tetanus of the human subject. Nocard, in the following year, demonstrated the bacillus in the pus from a horse affected with the disease; and Kitasato, in 1889, was the first to obtain a pure culture of the bacillus, and to prove that the subcutaneous inoculation of animals therewith causes tetanus.

Tetanus bacilli, or their spores, are commonly present in garden soil and in the dust and sweepings of town streets, have been detected in splinters from the woodwork of houses, in stable manure, in the fæces of the horse, ox, calf, and other herbivorous animals, and occasionally in the fæces of man.

In nearly all cases of tetanus the virus can be shown to have entered the body through a wound of the surface, and the cases are, therefore, known as "traumatic tetanus." The wound is usually situated on one of the limbs. Lacerated, contused, and especially deep punctured wounds, are most liable to be followed by tetanus, but still more so if the wound have been contaminated with soil or manure, or have become septic. Wounds caused by wooden splinters and nails are notably dangerous, and gunshot wounds are not infrequently followed by tetanus, as is shown by the frequency of what is termed in the United States "Fourth of July tetanus." The occurrence of tetanus after surgical operations is now relatively uncommon. Tetanus has lately been recorded as occurring after vaccination, but as the vaccine lymph in question was proved by animal experiment to be innocuous, secondary infection of the vaccine wound had evidently taken place at some period subsequent to the act of vaccination. Tetanus has been known to follow hypodermic injections, as has recently been recorded by Moty (1901) in the case of quinine injections. In such instances the disease is usually the result of secondary infection. Of late a few cases of tetanus have been observed subsequent to the subcutaneous injection of gelatine in the treatment of hæmorrhage or inoperable aneurysm, and tetanus bacilli have been detected in commercial gelatine by Levy and Bruns (*Mitteil. a. d. Grenzg. d. Med. u. Chir.* 1902), and also by Schmiedicke (1902). A number of cases of tetanus, twenty of them being fatal, have been recently recorded after the use of antidiphtheria serum prepared in Milan and St. Louis.

The Milan serum was, on investigation, found to contain tetanus bacilli, whereas the St. Louis serum was sterile, but contained tetanus toxin in considerable amount. Such accidents as these must be of exceptional rarity, and cannot occur in the case of sera which have been properly tested on animals. Tetanus is a not infrequent complication in soldiers wounded in war. In the recent Madagascar campaign there was considerable mortality from tetanus, and in the French colonial wars during the latter half of the last century the mortality due to tetanus among the wounded averaged three to five per cent (Calmette, 1900). In the Spanish-American war the Spanish losses from tetanus were severe, whereas in the last Boer war the disease was almost non-existent.

Puerperal tetanus and *tetanus neonatorum* may be regarded as special forms of traumatic tetanus, infection occurring from the female genital tract and from the umbilical wound respectively. In the tropics tetanus is often observed in epidemic form in new-born children, illustrating the fact that when there is a wound contaminated by soil or other infective material, and when asepsis or antisepsis is not carried out, tetanus is likely to supervene.

In exceptional cases no wound can be found, nor is there any history of a wound. These are the cases designated "idiopathic tetanus." In some of these instances there has probably been a wound so trivial as to have escaped detection; in others we may conclude from the researches of Thalmann (1900) and others that a lesion of the nose, mouth, respiratory, or alimentary tract served as the point of entrance of the virus.

The disease is more frequent in negroes than in white persons, but affects the latter more than the yellow races, and is more prevalent in tropical than in temperate or cold climates. It is common on the west coast of Africa, in the West India Islands, and in Cochin China. In New York there were in 1899 seventy-three deaths from tetanus; in Baltimore in 1901, thirty-two deaths; in the hospitals in Vienna during 1899 there were fourteen cases, of which eight terminated fatally. In Great Britain the disease is relatively infrequent.

THE TETANUS BACILLUS is a small thin bacillus, about 2–5 μ in length; in cultures it often forms longer filaments. The bacillus possesses ten or more flagellæ, is slightly motile, and in cultures forms a terminal round spore, the diameter of which is greater than that of the vegetative cell, the bacillus thus assuming the drumstick or pin form.

The bacilli can be stained by any of the ordinary stains, and retains the stain when treated by Grams' method. The spore may be differentiated from the rest of the bacillus by the usual methods for demonstrating spores.

The bacillus is more readily cultivated at a temperature of 37° C. than at the room temperature; growth ceases if the temperature be below 14° C. The bacillus is usually regarded as an obligatory anaerobe. Growth is certainly most readily obtained in the entire absence of oxygen, and the addition of glucose or sodium formate to the medium favours growth. On the surface of gelatine the colonies are small, irregular, of greyish white colour, the margin of a colony, when seen under the microscope, presenting numerous thin, radiate projections. The medium is slowly liquefied. On the surface of agar each colony is whitish in colour, and is surrounded by a thin halo of fine, wavy, thread-like projections from its margin. Stab cultures in glucose agar or gelatine present in the deeper part of the medium abundant fine lines of growth, projecting at right angles from the needle track, the growth thereby assuming a resemblance to a bottle brush or fir-tree. Gas is formed, and if the medium be gelatine it becomes liquefied. Glucose bouillon is rendered turbid, and gas is evolved, whereas milk remains unaltered. Of late years a number of observers (Carbonne and Perrero, 1895; Kruse, 1896; Grixoni, 1899; Debrand, 1902; etc.) have shown that the bacillus is by no means so strictly anaerobic as was formerly supposed, and some have maintained that it can grow under aerobic conditions. This assertion is in part true, for the tetanus bacillus undoubtedly multiplies when cultivated in bouillon together with some other bacterium, for example bacillus subtilis, which absorbs oxygen from the medium; and further, both Zumpe (1899) and Debrand (*Annales de l'Inst. Pasteur*, 1902, xvi.) have shown that the tetanus toxin elaborated under such conditions is as virulent as the toxin obtained by the ordinary anaerobic methods. In other instances the bacilli cultivated under aerobic conditions have been avirulent, and have consequently been regarded as pseudo-tetanus bacilli. The tetanus bacillus does not grow in media containing no trace of proteid.

The vitality of the spores is well maintained for a long period. A wooden splinter, for instance, was proved to be virulent eleven years after removal from a case of tetanus (Henrijean, 1891). The spores are also markedly resistent. They are killed by five per cent carbolic acid in fifteen hours, by one per thousand mercuric chloride in three hours, by moist heat at 100° C. in from five to thirty minutes, according to their resistent power, but withstand moist heat at 80° C. for one hour. Exposure to dry heat at a temperature of 155° C. destroys them in twenty minutes.

There is much difference in the *susceptibility* of the various animal species to tetanus. The most highly susceptible are the horse and man, somewhat less susceptible are the goat, guinea-pig, mouse, donkey, and ox; still less susceptible are the rabbit, rat, dog, and cat. Pigeons, crows, and parrots are but little susceptible. The fowl is still more highly immune. Knorr (1897) states that the minimum toxic dose for the fowl is equal to the 0·001 part of the minimum lethal dose for the horse. Frogs, after inoculation, do not acquire the disease unless kept at 37° C. Lizards and tortoises have not yet been shown to be susceptible.

The usual modes of entrance of the virus into the body have been already mentioned. The introduction of spores into the healthy respiratory passages (Thalmann, 1900), or into the normal alimentary tract (Sanchez Toledo, 1890), does not cause infection, but the virus may gain entrance through a wound of the nasal mucous membrane, or through the alimentary tract (Suess, 1901), or the deeper parts of the respiratory tract when the latter are in a state of catarrhal inflammation. If the virus has been introduced into the subcutaneous tissues it there finds anaerobic conditions, well adapted for its existence and multiplication. The spores germinate, the resulting bacilli multiply, but remain localised at this situation, and do not invade the body, although in exceptional instances they may penetrate as far as the neighbouring lymph glands (Schnitzler and Büdinger, 1893). The bacilli multiplying, now elaborate their toxin, which is carried away to the spinal cord and medulla by the blood stream, and also, so it is supposed by some, along the peripheral nerves. A point of no little importance is that the introduction into the normal tissues of tetanus spores alone—all traces of toxin having been previously removed from the spores by washing with water, or by heat for twenty minutes at 65° C.—does not induce tetanus (Vaillard and Vincent, 1891; Vaillard and Rouget, 1892, 1893). If, however, the spores be introduced into damaged tissue, or be introduced together with some substance such as cultures of other bacteria, lactic acid, or other chemical substance, capable of inducing damage, or of exerting a negative chemiotactic influence on the leucocytes, the spores germinate and the bacilli form their toxin. The same result is attained by enclosing the spores in collodion sacs, and thereby protecting them from the leucocytes. In every case of natural infection with tetanus, spores alone are never introduced. The presence of some or other foreign substance in the wound usually implies the simultaneous presence of other bacteria, hence in most cases of tetanus there is mixed infection from the outset, and suppuration at the seat of the wound.

Tetanus Toxin.—All the features of this disease can be reproduced by injection of tetanus toxin obtained by filtration from cultures. The exact chemical nature of the purified toxin is still uncertain—Brieger and Boer (1896) found that it yielded no proteid reactions; Hayashi (1901) regards it as an albumose. In many respects it resembles the enzymes. Thus it is destroyed in a few minutes by moist heat at 65° C.; three hours' exposure to dry heat at 140° C. is required to completely destroy dry tetanus toxin (Morax and Marie, 1902); and, in contradistinction to inorganic poisons such as strychnine, there is an incubation period between the injection of toxin and the first symptoms of tetanus. The purified toxin is extremely virulent; 0·000,000,05 gram suffices to kill a mouse weighing about 15 grams. The activity of the soluble toxin in filtered cultures undergoes reduction with age, on exposure to air or sunlight, or by the addition of chemicals such as iodine salts. This change is due to dissociation of the constituent elements of the toxin one from another, *i.e.* to the formation of toxoids which are relatively inert.

The toxin is absorbed from the wound into the blood. In the case of the guinea-pig the toxin remains in the blood for a relatively long period; whereas in the case of the rabbit and of man the greater part of the toxin soon passes out of the blood and becomes fixed in certain cells—mainly those of the central nervous system—which have an affinity for it. Nearly all investigators agree that the toxin is, after death, contained in the central nervous system (Asakawa, 1898; Pasquini, 1902; etc.), but the presence of the toxin in other organs, in the cerebro-spinal fluid, and urine is very inconstant.

THE INCUBATION PERIOD varies according to the amount of toxin administered and the site of injection, but is always present even after very large doses. On subcutaneous injection of moderate doses the incubation period in man is four to seven days, in the horse, five days; in the guinea-pig, two days; in the rabbit, two to four days; in the mouse, two to three days. Courmont and Doyen explained this incubation period by supposing that the substance formed in vitro which one injects is not really the toxin, but merely an enzyme, the action of which on the organism results in the formation of the true toxin. They found that the blood of a tetanic dog produced immediate tetanic symptoms when injected into healthy dogs, and concluded that in such a case the true toxin, the effect of which was manifested without any incubation period, had been injected. We now know, however, from the investigations of Buschke and Oergel (1893), of Blumenthal (1897), Waring, Andrewes (1902), and others, that extracts from the spleen, liver, and other organs of animals or persons who have died of tetanus, may cause tetanic symptoms within five to thirty minutes of injection, the probable explanation being that the toxin has combined with the cellular elements of the organs, and thereby acquired the capacity of inducing tetanic phenomena without any, or with only a very brief, incubation period.

ACTION OF THE TOXIN.—It has been proved to produce the tetanic spasms by acting on the motor cells of the spinal cord and medulla oblongata so as to increase their irritability. The toxin has no action upon the muscular fibres or peripheral nerves; curara inhibits the spasms, and section of a motor nerve causes the spasms to cease in the region it supplies. After injection of the toxin into animals, *e.g.* mice, the spasms occur first near the seat of injection. This fact has been interpreted in a variety of ways; according to Marie (1897) and many subsequent writers it indicates that part of the toxin is carried away by the peripheral nerves.

The toxin does not induce any characteristic change in the central nervous system. The various appearances, hæmorrhages in the anterior horns, degenerative changes in the motor cells of the spinal cord, etc. are not constant, and have been observed after injection of other poisons (Goldscheider and Flatau, 1897; Kossel and Westphal, 1898). The most satisfactory and most commonly accepted explanation of the action of tetanus toxin on the nerve cells is afforded by Ehrlich's side chain theory (1897, etc.) According to this theory, the toxin possesses two groups of molecules: (1) a haptophoric group which has an affinity for similar groups of molecules—side chains—in the nerve cell, the toxin becoming thereby anchored or fixed in the cell; and (2) a toxophoric group which, subsequent to the fixation of the toxin in the cell, increases the irritability of the cell-protoplasm. The fixation of the toxin in the nerve cells is a gradual process, requiring some time for its completion, and consequently there is an incubation period before tetanic symptoms arise. The nerve cells liberate or cast off those side chains which have combined with the toxin, and there is then a regeneration of side chains. If this regeneration be excessive the newly-formed side chains pass from the nerve cells into the blood, still retain their power of combining with toxin, and now represent the antitoxin. The presence of preformed tetanus antitoxin in the spinal cord and brain of animals and of man has been proved by Wassermann and Takaki, Metchnikoff, Marie (1898), Danysz (1899), and others, and Babes (1899) has shown that brain substance also contains preformed rabic antitoxin. Yet although tetanus toxin is rendered innocuous by admixture in vitro with brain substance, the presence of preformed antitoxin in the nerve cells of an animal does not render it immune to tetanus toxin. Natural immunity to the toxin is due to the absence of cells possessing a haptophoric group of molecules with an affinity for tetanus toxin; whereas acquired immunity to the toxin is obtained only by the presence of the antitoxin in the blood (*vide* "IMMUNITY," vol. v.)

When given by the mouth the toxin is innocuous (Ransom, 1898; Carrière, 1899; Cano-Brusco, 1901, etc.); its direct introduction into the cerebrum is followed by "cerebral tetanus" characterised by epileptiform attacks, polyuria, and psychical symptoms (Roux and Borrel, 1898). Binot (1899) states that the introduction of the toxin into the uterus, testicle, bladder, or kidney, induces not the ordinary tetanic spasms, but a peculiar condition which he terms "splanchnic tetanus," and Metchnikoff has found that the ovary of the hen contains substances which combine with the toxin in vitro. These facts show that there are cells, other than those of the spinal cord and medulla oblongata, with an affinity for, and capable of combining with tetanus toxin. In tetanus due to natural infection or to subcutaneous or intravenous injection of toxin, however, the toxin is mainly, if not entirely, fixed in the motor cells of the spinal cord and medulla oblongata.

CLINICAL FEATURES OF TETANUS.—The disease is more frequent in men than in women. The incubation period varies from about four days to four weeks, but is rarely longer. According to Rose, the earliest tetanic symptoms appear during the first week in 33 per cent of cases, during the second week in 45 per cent. The tetanic spasms commence in the muscles of mastication, the earliest symptoms being stiffness of the jaws (trismus) and of the neck. The tonic spasms then involve the facial muscles; the eyebrows are elevated, the angles of the mouth are drawn outwards, giving the characteristic tetanic facies or risus sardonicus. The spasm of the muscles of mastication becoming more intense, the mouth can be opened very slightly if at all. The tonic spasms now involve the muscles of the trunk and limbs, and the patient's body becomes rigid throughout. Exacerbations of the spasms, associated with great pain, are brought on by slight stimuli such as a sound, touch, draught of air, or attempt to swallow. In a paroxysm the jaws are firmly clenched, and the patient's body perfectly rigid (orthotonos), becomes arched backwards (opisthotonos), forwards (emprosthotonos), or to one side (pleurosthotonos). During the paroxysms the pain is intense, perspiration is profuse, the respirations are rapid or irregular; consciousness is maintained throughout. The temperature is either normal or elevated to a varying degree, but before death often rises to 105° F., and after death to 109° or 110° F. In fatal cases death is due to asphyxia from spasm of the respiratory muscles, to cardiac failure or exhaustion; or in rarer instances to cerebral hæmorrhage or aspiration pneumonia.

Cephalic (*facial*) *tetanus* is a special form of traumatic tetanus, there being a wound in the area of distribution of the facial nerve with paralysis of this nerve on the injured side, in addition to the ordinary signs of tetanus.

In *puerperal tetanus* infection is usually consequent upon abortion or abnormal labour, and is often due to the ignorance of midwives regarding asepsis.

Tetanus Neonatorum.—Difficulty in sucking is the earliest sign of importance, and is followed by tetanic spasms as in the adult. The prognosis is bad, death not infrequently occurring within one to four days.

Diagnosis.—The patient should be examined in order to determine the presence or absence of a recent wound, and if possible a bacteriological examination of the pus or tissue of the wound should be made. In nearly all cases there is mixed infection, but in not a few cases it will be found that tetanus bacilli cannot be cultivated owing to the fact that they have been already destroyed by the leucocytes and tissue cells. The presence of the toxin may, however, be proved by injection into animals of the discharge from the wound or possibly of the patient's urine. In the early stages of the disease, tetanus might be mistaken for rheumatism of the temporo-maxillary joint, or an inflammatory affection of the parotid or tonsils. In tetanus there is no local swelling or tenderness, but there is a tonic spasm of both masseter muscles, a fact which is elicited most definitely by the introduction of a finger into the patient's mouth. A more advanced case may be mistaken for one of strychnine poisoning. There is, however, no rigidity in the intervals between the paroxysmal spasms caused by strychnine, involvement of the muscles of mastication is a late phenomenon, and in an acute case death often occurs within twenty minutes after the onset of symptoms. Other conditions with which tetanus might be confounded are tetany, cerebro-spinal meningitis, hydrophobia, and hysteria.

Prognosis.—The shorter the incubation period the more severe will the disease be. The rapid involvement of different groups of muscles, severe and frequently occurring paroxysms, elevation of the temperature, and persistence of symptoms in spite of treatment, are unfavourable signs.

Prophylaxis.—When there is a wound contaminated by soil, manure, or other material likely to contain tetanus spores, it should be thoroughly cleansed, splinters, nails, or other foreign bodies being removed. It may be advisable to open up and drain a pre-existing wound, and if there be reason to suspect tetanus infection, a prophylactic injection of tetanus antitoxin should be given (5-10 c.c., which may be repeated). The prophylactic value of antitoxic serum has been amply demonstrated in the horse (Nocard, 1897).

Treatment.—The first and most important point is the neutralisation of any toxin still circulating in the blood and not yet fixed in the nerve cells. This can be effected with certainty by injection of tetanus antitoxin, which was first obtained by Behring and Kitasato in 1890. The methods of obtaining the antitoxic serum from actively immunised animals and of standardising the serum have been already considered (*vide* "Immunity," vol. v.) Injection of tetanus antitoxin into animals protects them not only against the subsequent injection of tetanus toxin, but when injected after tetanic symptoms have appeared may even then effect a cure. When in men the first signs of tetanus appear, much of the toxin is already fixed in the nerve cells, but there is still toxin circulating through the body, and in many instances fresh toxin is still being elaborated by the bacilli in the wound. It is usually admitted that injection of tetanus antitoxin does not withdraw from the nerve cells the toxin already fixed in them, but it has been proved that antitoxin when injected does combine with, and thus render innocuous, the toxin which is still in the circulating fluids, or which the bacilli may yet elaborate. As the antitoxin does not influence the nerve cells already damaged by the toxin, it has consequently no directly curative action; but injection of antitoxin will effectually prevent any further fixation of toxin in the nerve cells, may therefore prevent a mild case from becoming severe, and, as Ullrich (1902) remarks, obviates the necessity for amputation of the wounded part. Prior to the introduction of antitoxin the mortality from tetanus amounted to about 80-90 per cent, although only about 45-50 per cent in the milder cases having a prolonged incubation period. With antitoxin treatment the mortality is reckoned at 34·4 per cent by Köhler (1898), 39·5 per cent by Lund (1898), and 43 per cent by Holsti (1899).

The antitoxin must be given as early as possible, in sufficient amount, and part thereof should be injected in the neighbourhood of the seat of infection. According to Behring, one must inject the serum not later than thirty hours after the appearance of the first tetanic symptoms, give not less than 100 units at one time, and repeat the dose frequently. Statistics show, however, that the sooner antitoxin is injected the greater is the mortality. Thus Haberling (Brun's *Beitr. z. klin. Chir.* Bd. xxiv.) in fourteen cases in which antitoxin was given within thirty-six hours after onset of symptoms, found the mortality to be 71 per cent; and Ullrich, having collected forty-one cases in which the serum was injected within thirty hours, found the mortality to be 72·9 per cent; whereas in seventy-two cases in which antitoxic treatment was commenced between the second and fifth days of the illness, the mortality was 45·5 per cent. The explanation of these facts is that those cases in which treatment was commenced early were the more severe cases.

The unsatisfactory results obtained by the subcutaneous injection of antitoxin have lead to intravenous, intracerebral (Roux and Borrel, 1898), and subdural or subarachnoid (Blumenthal and Jacob, 1898) methods of injection being tried. In subarachnoid injection the needle of the syringe is introduced between the third and fourth lumbar vertebræ, 10-20 c.c. of cerebro-spinal fluid are withdrawn, and then the same quantity of antitoxic serum is slowly injected. In intracerebral injection, 2-3 c.c. of serum are slowly injected into the substance of the brain in front of the motor convolutions on both sides. Intracerebral injection appears, from the results of experimental research, to be the most efficacious method, but in practice it is of very doubtful value. Lambert (1900) has collected fifty-two cases treated by this method, the mortality being 63·46 per cent; twenty-four of the cases were acute, and in them the mortality was 87·5 per cent. On theoretical grounds the subarachnoid method is to be preferred. Descos and Barthélemy (*Compt. rend. de la soc. de Biol.* 1902) in two cases of well-marked experimental tetanus have obtained a cure by this method, whilst von Leyden and Blumenthal (1900) and others advocate the employment of this method, either by itself or in association with subcutaneous injections.

There are a number of dried and fluid antitoxic sera obtainable: Behring's, Burroughs and Wellcome's, Parke Davis', and Tizzoni's sera, and the serum of the Pasteur Institute, etc. Whichever preparation be used, the dose for subcutaneous injection is 10-50 c.c. of fluid serum, or five grams of dried serum dissolved in sterile water. The frequency with which the injections are repeated and the total quantity of serum given will depend on the severity of the case. The syringe must be cool, aseptic, and free of all trace of antiseptic.

The injection of brain substance as a therapeutic measure is based on the experiments of Wassermann and Takaki (1898), who found that tetanus toxin combines in vitro with brain substance and is thereby rendered innocuous, and that mice could be saved even when brain or spinal cord substance was injected several hours after the toxin. These facts have since been amply confirmed by Danysz (1899), E. Marx (1902), and others. Cases successfully treated by subcutaneous injection of brain snbstance have been recorded by Kadyi (1899), Krokiewicz (1899, 1900), etc. But in the hands of many others the treatment has not been satisfactory. And as tetanus toxin combines more readily with antitoxin in solution than with the preformed antitoxin of the central nervous system, the hypodermic injection of brain or cord substance is not to be recommended.

Baccelli's method of treatment by subcutaneous injection of 2-3 per cent solution of carbolic acid is reported to have been successful by many Italian writers. Ascoli (1899), for example, records thirty-three cases treated by this method with only one death. But experimental investigations prove Baccelli's method to be valueless. Courmont and Doyen (1899) have found that it hastens the progress of the disease in guinea-pigs. Von Török (1900) has observed that it does not save rabbits after injection of tetanus toxin, and Guillaumin (*Jour. de Physiol. et de Pathol. Gén.* 1902) has found that Baccelli's treatment, even when commenced at the beginning of the incubation period, does not check the course of tetanus experimentally induced in the horse.

The wound should receive local treatment in order that the tetanus bacilli and other bacteria present may be destroyed. The wound should be enlarged, all foreign matter removed, and an antiseptic dressing applied, with drainage if necessary. The patient's strength must be maintained by careful feeding. Liquid food is the most suitable, and if it cannot be administered by the mouth, it must be given through a nasal tube or per rectum. And, lastly, treatment must be directed to the symptoms induced by the toxin. The reflex irritability of the central nervous system must be diminished by strict isolation of the patient. He must be in a darkened room and protected from all noise. Narcotics must be given. Morphia in large doses is the most beneficial; chloral hydrate, bromides, curara, cannabis indica, or other narcotics, are also useful in controlling the spasms, but chloroform is required if the paroxysms are very severe.

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Tetany.

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DEFINITION.—An affection characterised by tonic spasm, intermittent, remittent, or continuous, of the extremities; associated, as a rule, with sensory symptoms, and with an increase in the irritability of the muscles and nerves to electrical and to mechanical stimulation.

SYNONYMS.—Intermittent tetanus (Dance); idiopathic contracture (Teissier and Hermel); tetanilla (Trousseau); rheumatic contracture of nurses (Trousseau); tetany (L. Corvisart); intermittent rheumatic contracture; tonic occupation spasm; arthro-gryposis, etc.

HISTORY.—The discovery of this affection is usually attributed to Steinberg, who, in 1830, described it as a "rheumatic contraction of the extremities"; and to Dance who, in 1831, published a memoir upon "A Form of Intermittent Tetanus." Before that date, however, as Risien Russell has pointed out, cases in which rigidity of the extremities was associated with spasm of the glottis, were described by Clarke in his *Commentaries on some of the most important Diseases of Children,* published in 1815, these being obviously cases presenting the common association of carpo-pedal spasm and laryngismus.

In 1846 Delpech, Trousseau's assistant, wrote a thesis on *Idiopathic Muscular Spasms,* in which he described a number of cases. In 1852 the name "tetany," by which the affection is now generally known, was proposed by Lucien Corvisart.

The disease became generally known in this country through the writings of Trousseau, who collected a considerable number of cases at the Necker Hospital. As the earlier cases were in nursing women, Trousseau at first regarded the disease as special to nurses, and called it *Rheumatic Contraction occurring in Nurses* (*Contracture rheumatis male des nourrices*), but, as he himself says, he was not long in discovering that nursing is not the only favourable condition for its development.

The association of tetany with dilatation of the stomach was first described by Neumann in 1861, and since that time similar cases have attracted a great deal of interest.

A very severe form of tetany sometimes occurs in cases of complete extirpation of the thyroid. An account of such cases, occurring in Billroth's clinique, was published by Weiss in 1880, and the conclusions drawn from clinical observation have found support in the experimental investigations of Horsley, Schiff, and others upon the thyroid gland.

The toxic theory of the origin of tetany has led to experimental studies by Müller, Bouveret and Devie, Halliburton and M'Kendrick, and others.

CAUSATION.—1. *Age and Sex.*—Tetany is met with at all periods of life. If we regard the carpo-pedal spasms of rachitic children as a minor form of tetany, the affection is most common in childhood. Gowers collected 150 cases, of which 142 were available for tabulation according to age and sex. In the successive decades the cases numbered 42, 36, 24, 23, 13, 4. Above the age of twenty, women are more frequently affected than men. Trousseau speaks of the disease as most common in women between the ages of seventeen and thirty. In childhood, on the other hand, the spasms occur much more frequently in boys than in girls. Of the 42 cases in the first decennium 31 were boys and 11 were girls.

2. *Heredity.*—Sometimes several cases occur in a family. Thus Abercrombie quotes four cases as occurring in each of two families, and three cases in one family, at different times. Again, cases are recorded in which the patient had suffered from convulsions, or was morbidly irritable and impulsive, subject to outbursts of temper for trifling causes, or in some other way gave evidence of nervous instability. On the whole, however, the evidence is against the general existence of any particular neuropathic heredity in the subjects of tetany.

3. *Geographical Distribution.*—While tetany has a very wide geographical distribution it is in most places an infrequent disease. In some parts of the continent of Europe, however, it is comparatively frequent, especially in Vienna, where it is said to be becoming more common. In America true tetany is a very rare disease, and in this country it is far from common. The mild form which occurs in children is met with much more frequently than cases in adults.

4. *Season.*—Tetany is more common in winter and spring than in summer and autumn.

5. *Various Special Conditions.*—Tetany occurs under such a variety of conditions that it is necessary to attempt some classification of the cases. The following grouping is that adopted by Frankl-Hochwart in his elaborate paper:—

GROUP I.—*Cases occurring in Healthy Individuals—Example: Epidemic Tetany.*—Tetany may occur in epidemic form, the cases being acute, running a course of two or three weeks, and rarely proving fatal. Such outbreaks have been observed especially in certain parts of the continent of Europe (*e.g.* Vienna). The victims are for the most part young men of the working-class, and particularly of certain trades. Frankl-Hochwart collected 360 cases from the registers of the General Hospital at Vienna between the years 1880 and 1889. Of the total, 318 were men, and of these 141 were shoemakers and 72 were tailors. The majority of cases occurred in February, March, and April. Von Jaksch regards the disease as infectious.

In 1876 a peculiar epidemic of tonic intermitting spasm appeared at a girls' school at Gentilly in France. Probably some of these cases were genuine tetany, and the remainder were hysterical simulations.

GROUP. II.—*Tetany associated with Gastro-intestinal Affections.*—Tetany may arise in definite association with various acute affections, such as acute dyspepsia, gastro-enteritis, peritonitis, and appendicitis. Diarrhœa plays a much more important part in causation when it is chronic and exhausting in character than when it is acute. Trousseau speaks of chronic diarrhœa as almost constantly present in his cases.

In exceptional instances obstinate constipation has been present, and the symptoms have been relieved by the administration of purgatives. Catarrhal jaundice and the presence of entozoa have also been regarded as causes.

Many cases of tetany have been observed in association with chronic affections of the stomach. Schlesinger speaks of a chronic benign form of tetany of gastric origin, and such a designation may be useful for the description of certain cases. A far more important group is formed by cases of a peculiarly severe type which occur in association with dilatation of the stomach. This association was described by Neumann in 1861, and by Kussmaul in 1869, and since then numerous cases have been reported. This form of the affection is usually very severe and the mortality is very high. Frankl-Hochwart gives only one recovery in 11 cases of the more serious kind. In most instances of this class pyloric or duodenal disease has been present. In a few cases compression of the duodenum from without has been discovered post-mortem. Primary affections of parts of the stomach other than the duodenum, and primary atrophy of the stomach-walls, are much more rarely associated with this form of tetany.

GROUP III.—*Tetany in Acute Infectious Diseases.*—Trousseau met with many cases after cholera in 1854, and Aran after typhoid fever in 1855. Cases have also followed or complicated small-pox, measles, scarlet fever, diphtheria, influenza, pneumonia, malaria.

GROUP IV.—*Toxic Conditions.*—Tetany has been attributed to definite toxic conditions, especially to chronic ergotism. It has, however, been suggested that such cases may have been true tetany due, not to a specific poison, but to "general deterioration of the health from a defective supply of nutriment" (C. H. Fagge).

Alcohol, chloroform, morphia, and lead have also been regarded as possible causes in particular cases.

Albumin has been present in the urine in a number of cases, and glucose and acetone have also been found. Indicanuria is not infrequent, especially in children. Chronic disease of the kidneys has been discovered post-mortem in cases in which no abnormal constituents were noted in the urine during life. It has been suggested that such changes may indicate damage done to the kidneys during the excretion of some unknown toxic substance.

GROUP V.—*Tetany in Pregnant, Parturient, and Nursing Women.*—In a large proportion of cases of tetany some debilitating influence is present. Prolonged lactation is an important cause which has been mentioned already. In such cases the incidence of the disease may be determined by fatigue or exposure to cold. The disease may occur during pregnancy, in which case the symptoms are more apt to appear in the later than in the earlier months. The affection may reappear during successive pregnancies. Young girls are said sometimes to be attacked shortly before puberty.

GROUP VI.—*Extirpation of the Thyroid*—Complete extirpation of the thyroid gland may be followed by tetany. Only one or two cases have been reported as occurring after partial excision. In one, at least, of these cases the part of the gland left behind was obviously diseased. Out of 78 cases of complete excision at Billroth's clinique 13 cases of tetany occurred. Tetany may be produced experimentally in dogs by excision of the thyroid.

SYMPTOMS.—(*a*) *Prodromal Stage.*—Some writers describe a prodromal stage, characterised by headache, backache, weariness, occasionally giddiness, and frequently digestive disturbance. These symptoms may last for a few days before a sensation of tingling in the extremities ushers in the characteristic motor symptoms. More commonly the affection begins acutely with little or no premonitory sensory disturbance.

(*b*) *Motor Symptoms.*—The characteristic symptom is spasm of the hands and feet. The spasm is usually symmetrical. The hands are affected first, the feet later. In most cases the thumb is adducted or flexed on the palm, the fingers are pressed close together, slightly flexed at the metacarpo-phalangeal joints, and extended at the terminal joints. The palm is hollowed by the approximation of the lateral borders. Trousseau compared the position to the accoucheur's hand when about to be passed into the vagina. In some cases the fingers are flexed so that the nails press upon and even injure the skin. Rarely they are fully extended, or the position is the "*main en griffe.*" The wrists are slightly flexed, and the fore-arms pronated. The upper-arms may be closely adducted to the sides, while the shoulders are free from spasm. In the lower extremities the toes are usually flexed and pressed together, and the feet are extended at the ankle-joint and inverted. The knees are usually extended, and the thighs may be strongly adducted.

In slight cases the extremities are affected alone, but in severe cases the spasm may be very widely spread. The muscles of the face may be affected, and the angles of the mouth drawn out into a grin. The ocular muscles may be involved, resulting in strabismus. Trismus may be present, but is rare. The muscles of the tongue may be affected, producing difficulty in swallowing and in articulation.

The head is more frequently drawn forwards than backwards. Opisthotonos, however, may be present, usually as a late symptom, and such cases may readily be mistaken for tetanus. The involvement of the thoracic muscles and of the diaphragm may cause serious dyspnœa. The abdominal muscles become tense and rigid, and in some cases spasmodic retention of urine has occurred.

The spasms are usually paroxysmal. In an attack of tetany there are usually several paroxysms separated from one another by an interval which varies from an hour or two to several days. The whole attack usually lasts for two or three weeks, but it may continue for several months. The paroxysm may cease suddenly. More commonly it passes off gradually, and in the reverse order to that in which it supervened. Between the paroxysms more or less contracture of the affected muscles may persist, especially in the arms, and if an attempt is made to overcome this either by an effort at voluntary movement or by passive manipulation, a fresh paroxysm is apt to be precipitated. The spasms have been described as continuous, remittent, and intermittent, but these varieties shade off into one another.

The spasm may persist during sleep, and even, according to Abercrombie, during narcotisation with chloroform. Cold applied to the affected parts will sometimes stop the spasm.

Between the attacks, as Trousseau accidentally discovered, the paroxysm may be reproduced "by simply compressing the affected parts, either in the direction of their principal nerve-trunks, or over their blood-vessels, so as to impede the venous or arterial circulation." *Trousseau's symptom*, as this phenomenon is called, is of considerable value in diagnosis, but it may be absent in otherwise typical cases. It has been attributed to ischæmia, but is now ascribed by most writers to direct irritation of the nerve-trunks.

Another sign of diagnostic importance is that known as *Chvostek's*. This phenomenon consists in the presence of such a high degree of irritability of the muscles and motor nerves to mechanical stimulation that a tap over either the muscle or the nerve will produce a muscular contraction. This hyperexcitability is not confined to the affected parts. It can often be readily demonstrated by a slight tap over the facial nerve which will produce a momentary contraction of all the muscles supplied by the nerve, or by the particular branch which is struck.

The *electrical reactions* have been carefully studied by Erb, Frankl-Hochwart, and others, who have found an increased irritability to the galvanic current almost constantly, and to the faradic current rarely. The polar reactions are also altered, so that a more ready response is obtained with the anode than with the cathode. The contraction is more prolonged than in health, and a feature peculiar to tetany is an anodal opening tetanus.

(*c*) *Reflexes.*—The tendon reflexes vary. They have been found normal (Baginsky), exaggerated (Loos), or absent. The stiffness of the muscles may interfere greatly with examination.

(*d*) *Sensory Symptoms.*—Premonitory sensory symptoms may be absent, or there may be tingling and formication in the hands and feet before the attack begins. Numbness or anæsthesia may be present. The muscular spasms are attended by cramp-like pain in proportion to the severity of the paroxysm. Articular pains in the joints of the affected area are also described.

(*e*) *Vaso-motor and Trophic Phenomena.*—During a paroxysm the face may become congested, and the lips purple, and there may be cyanosis of the extremities, especially of the hands. Œdema of the dorsum of the hands and feet may be present, and the skin of the affected area may be red and tender to the touch.

(*f*) *General Symptoms.*—The temperature is usually normal. In some cases it may be slightly raised, and in one or two fatal cases there has been a high temperature at the time of death. The intelligence is unaffected, and in fatal cases the mind may remain clear till the end. To this rule, however, there are exceptions. Frankl-Hochwart states that he has met with hallucinatory confusion in three cases. Again the patient may die comatose, in which case the spasm does not necessarily pass off with the onset of the coma.

Tetany in Childhood.—Tetany is a much more common affection in children than in adults. It is most frequently met with in a mild form often called carpo-pedal spasm. Several authorities, including Henoch, have sought to draw a distinction between cases of this kind in young children and the true tetany of older subjects; but there does not appear to be any sufficient reason for doing so.

A subject of great interest is the relationship between tetany and rickets. This association was supported by Cheadle, and recently Kassowitz has argued with great vigour that tetany, as well as laryngismus and other nervous affections of young children, are to be regarded as manifestations of rickets. This view has been opposed by Kalischer, Loos, Romme, and others, who assert, on the one hand, that many children who suffer from tetany are not rachitic, and on the other, that if tetany is a rachitic affection it ought to be much more common than it is.

Upon this question it may be said that cases of tetany unconnected with rickets certainly do occur in childhood. These cases closely agree clinically with those met with in adults. They occur in association with the acute infectious fevers, with acute diseases such as pneumonia, with acute dyspepsia, with entozoa, with acute, and much more frequently with chronic diarrhœa. The symptoms may be slight, but are often severe. The onset of tetany in the course of measles or of some other general disease appears to have a grave prognostic significance.

A much larger group includes the ordinary cases of carpo-pedal spasm. This variety of tetany is met with chiefly in children younger than those just referred to, the majority of cases occurring in children in their second year. These cases are usually very mild; the spasm is usually confined to the extremities; as a rule it is continuous, or if paroxysms occur they are very slight. Facial irritability is almost always well marked. Trousseau's sign is often absent or difficult to obtain. Diarrhœa is present in a large proportion of the cases. The occurrence of general convulsions is an important complication which may supervene at any time during an attack. The general opinion in this country would agree with Kassowitz in regarding these cases as rachitic.

As to the statements of some continental physicians that a considerable proportion of children suffering from tetany present no evidence of rickets, so far as such observations are not to be explained by the inclusion of a considerable proportion of cases belonging to the first series, we can only say that in the early stages of rickets the symptoms are often not very definite, and even good observers may disagree as to whether a child is to be called rachitic or not.

The comparative frequency of laryngismus in children suffering from tetany is a feature of much interest. Some observers state that it is present in one-third of the cases. This has led Escherich to go so far as to maintain that laryngismus is a pathognomonic sign of tetany even when the characteristic spasms are absent (latent tetany).

Martin and other recent French writers have described as tetany certain cases of isolated spasms in different parts of the body (*les formes frustes*). These are alluded to in the section on Diagnosis.

Morbid Anatomy.—As the mortality in tetany is very low the number of post-mortem examinations has been small. In those which have been made changes in the nervous system have been slight or absent.

Necropsies on children have been made by Tonnellé, de la Berge, Abercrombie, Baginsky, Berger, and others. In some cases nothing abnormal was discovered. In others there was an excess of serum in the subarachnoid space or in the ventricles, hyperæmia of the pia, and areas of hyperæmia and œdema in the brain and spinal cord. Schultze found slight sclerosis in the cervical region of the cord on microscopic examination in the case of a child of eleven months, in which the nervous system appeared normal to the naked eye. In another child which he examined there were no microscopic changes.

Evidence of myelitis has been found in the cervical and lumbar enlargements of the cord in two children examined by Bonome and Cervesato. The principal alterations were found in the grey matter, and included degenerative changes in the nerve cells, especially those of the internal group of the anterior horn.

Some redness of the sheaths of the peripheral nerves has been noted in a few cases, but this may not have meant very much. Berger found nothing abnormal in the nerves on microscopic examination. Weigert, Loos, and Oddo have also failed to find changes in the nerves.

Observations made upon adults give practically the same results as those upon children. Trousseau describes, in the case of a young man, slight softening of the spinal cord, which he regarded, not as the cause, but as an effect of the disease. Langerhans found slight thickening of the small vessels,—just such changes as might be expected in an elderly patient, and his patient was forty-eight. Very few cases have been examined in which the disease was of great duration. Imbert-Gourbeyre examined the body of a tailor, twenty-one years of age, who had been subject to tetany for six years. Injection of the surface of the brain with slight ecchymosis was present, and there were also slight changes in the spinal cord, especially in the cervical and lumbar enlargements. Death in this case was due to small-pox.

In cases of tetany due to extirpation of the thyroid the nervous system has been found normal, or any changes present have been slight and indefinite. Similar negative results have been obtained in the case of animals suffering from tetany after experimental removal of the thyroid, by Schultze, Victor Horsley, Frankl-Hochwart, and others.

PATHOGENY.—It is now generally agreed that tetany is an affection of the nervous system. It is more difficult to decide which part of the nervous system is specially affected. Some of the symptoms might be referred to the peripheral nerves (Hasse), but the usual distribution of the affection seems rather to point to derangement of the spinal cord, and this view is further supported by the muscular atrophy which occasionally results, and by the changes which have been found in the cells of the spinal cord (Erb, Berger, Gowers). Frankl-Hochwart refers some of the symptoms (*e.g.* the rarely observed polyuria and glycosuria) to the medulla, and he and others have also referred to the possible implication of the cerebrum in certain cases.

Among the theories advanced to account for the symptoms the most important are the dehydration theory put forward by Kussmaul and afterwards disclaimed by him; the reflex theory supported by G. Sée, Müller, and Berlizheimer; and the toxic theory which is accepted by most writers at the present day. The rôle of toxines in the production of nervous disorders has been discussed so fully of late that it is unnecessary to enter upon any general discussion of the subject. Among the points in favour of the toxic origin of tetany may be mentioned—the wide distribution of such lesions as have been found in the nervous system; the usual existence of some condition likely to lower the resistive power; the actual discovery of toxic substances in certain cases; and the occurrence of tetany in epidemic form.

It is interesting to compare the groups in which tetany occurs with Robertson's[1] classification of the sources of toxic infections which we have to consider in the study of nervous diseases. These are—

(1) Exogenous poisons. Tetany has been ascribed in rare cases to alcohol, chloroform, morphia, lead (Frankl-Hochwart's group 4).

(2) Poisons formed within the body in the course of various infectious and non-infectious diseases—typhoid, cholera, etc. (groups 1 and 3).

(3) Poisons generated within the body owing to disorders of metabolism. Here we would place the cases occurring in pregnant and nursing women (group 5) in whom metabolism is greatly increased, and also the cases following fatigue or exposure to cold which lower the resistive power of the nervous system. The cases of tetany following excision of the thyroid may also be included here (group 6). To certain organs, *e.g.* the liver, pancreas, lymphatic glands, is now attributed the function of neutralising toxic products of metabolic activity and of thus protecting the body from their influence. If the thyroid has any such rôle to play its removal will

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[1] *Text-Book of Pathology in Relation to Mental Diseases.* W. F. Robertson, 1900.

allow an accumulation of toxin to take place, and this, if not otherwise neutralised, may act on the nervous system, producing tetany.

(4) Poisons generated in the alimentary canal producing an auto-intoxication of gastro-intestinal origin (group 2). Bouveret and Devic found in the stomach, in cases of gastric tetany, a substance which produced convulsions when injected into animals. They associated the production of this substance with excess of hydrochloric acid in the gastric juice. Others (Ewald, Blazicek) have reported cases in which free hydrochloric acid was absent. Halliburton and M'Kendrick have recently described a toxic substance which they found in the stomach contents in a case of tetany and gastrectasis.

To sum up, tetany may be regarded as a group of symptoms produced by the action on the nervous system of a toxic substance or substances which arise under different conditions, and whose nature is unknown.

DIAGNOSIS.—Nothing is easier than the recognition of tetany in a characteristic case. The diagnosis depends upon the onset, usually sudden, of the peculiar spasms in the limbs, their restriction to certain groups of muscles, the normal temperature, and the absence of cerebral symptoms. Moreover, Trousseau's symptom, Chvostek's symptom, and the altered reactions to galvanism (Erb's sign), are important aids to diagnosis.

In some cases diagnosis may be rendered difficult by the slightness of the symptoms, or their aberrant form. Some recent French writers describe as tetany cases of spasm involving only a single group of muscles, or even only a single muscle, such as one sterno-mastoid. Again, cases are met with in which the typical spasm is or has been present, but to only a very slight degree, while sensory symptoms, such as numbness and tingling, have monopolised the attention of the patient. In such cases the special diagnostic sign (Trousseau's, etc.) may be absent or doubtful. A careful study of the possible causes of the symptoms will often throw light on the diagnosis.

In other cases the intensity and generalisation of the spasm may give rise to difficulty in diagnosis. Trismus, stiffness of the neck, and opisthotonus are present occasionally in severe attacks, and are suggestive of *tetanus.* In tetany the spasms usually begin in the extremities and invade the trunk later, trismus is a late symptom, and is usually only slightly marked, the usual position of the hands and feet is characteristic, and the temperature is usually normal. The termination of the case also contrasts with that of tetanus, for most cases recover, although death from asphyxia or from some complication may occur.

Another disease for which the severe forms of tetany may be mistaken is *cerebro-spinal meningitis.* In this affection there is usually fever, mental symptoms are a prominent feature, and the pain radiates along the nerves instead of being a cramp-like pain in the muscles. Examination of the cerebro-spinal fluid would aid in diagnosis by indicating the existence of inflammation.

Tubercular meningitis is to be distinguished by its insidious onset, the headache, the vomiting, the constipation, the irregularity of the pupils, the altered rhythm of the respiration, and the slowness and irregularity of the pulse. In children tetany is most common in the second year; tubercular meningitis between the ages of three and five years.

Hysteria may simulate tetany very closely. If a study of the antecedents of the patient and careful scrutiny of the symptoms do not clear up the diagnosis the electrical irritability of the nerves should be examined. In hysteria this is unaltered.

Epilepsy, Jacksonian epilepsy, and *cerebral congestion* give rise to spasms, but can rarely be mistaken for tetany.

Tetanus neonatorum begins in the early days of life, and trismus is a prominent symptom and usually the first to be noticed. It results from infection through the umbilical wound. Perhaps no disease is so fatal. The occurrence of tetany in newly born children is denied by some writers, while others describe it as presenting all the symptoms of tetanus neonatorum, from which it differs in that trismus is slighter and appears later, and that recovery takes place usually in from ten to twenty days.

PROGNOSIS.—Tetany *per se* is not a dangerous disease, and a fatal issue is rare in uncomplicated cases. When tetany occurs in the course of an exhausting illness death may result from the original disease, and may even be accelerated by the fatigue produced by the spasms. When the spasm is generalised death may result from asphyxia.

In two forms of tetany only is the prognosis grave, namely, in that due to thyroidectomy and that due to dilatation of the stomach. In the former, however, the fatal issue may be averted by the administration of thyroid. In the latter, in which the mortality is estimated at from 70 to 75 per cent, treatment is unsatisfactory. Frankl-Hochwart has been quoted as giving a much higher mortality in these cases, but his figures suggest a tendency to regard the fatal issue as a test of whether a given case should be included in this group or not.

TREATMENT.—*Symptomatic.*—In order to reduce the number and severity of the attacks of painful spasm the patient should be kept at rest in a warm room. All unnecessary movement should be avoided. The diet should be nutritious and easily assimilated, the details being suited to the age and general condition of the patient. Warm baths are useful, especially in acute paroxysmal cases, and may be repeated several times in the day. The local application of cold may also give temporary relief to the spasm. Trousseau says the painful cramps in the legs are instantly relieved if the patient stands upon a cold stone or tiled floor.

Of drugs administered for the relief of spasm the bromides and chloral are generally useful. Calabar bean was recommended by Cheadle. For nocturnal tetany Gowers advocates a dose of digitalis at bedtime. When the paroxysms are very severe the inhalation of chloroform is indicated. The anæsthetic should be administered cautiously and with plenty of air, as there is some danger of spasm of the glottis occurring.

General.—The general line of treatment should be of a tonic character as is indicated by the usual underlying conditions. According to the special indications of the case such drugs may be ordered as quinine, arsenic, iron, phosphorus, the hypophosphites.

Special attention should be paid to the condition of the gastro-intestinal canal. Astringents may be used for the purpose of checking diarrhœa, or, in view of the possibility of the symptoms being due to a toxin of intestinal origin, calomel in small repeated doses, B. naphthol, salol, or salicylate of bismuth might be tried.

The urine should be examined as it may furnish indications for treatment. Means should be adopted to favour elimination by the kidneys, skin, etc. Russell states that the hypodermic administration of pilocarpine brings about rapid relaxation of the spasm as soon as diaphoresis is induced. Trousseau advocated bleeding from the arm in the case of patients of a vigorous constitution. Any benefit derived in this way may possibly have been due to elimination of a portion of the toxin.

Dilatation of the Stomach.—In cases associated with dilatation of the stomach lavage is now generally recommended, but it must be carried out cautiously as the passage of the tube may excite a paroxysm. The diet must be attended to, and hyperacidity corrected if present. Mayo Robson recommends surgical treatment, and reports cases in which the "cramps" ceased after pyloroplasty.

Excision of Thyroid.—In tetany following excision of the thyroid the appropriate treatment is obvious. In a few cases of tetany due to other causes thyroid treatment has been beneficial, but it is not generally useful.

Tetany in Children.—The chief indication is to attend to the underlying cause. Diarrhœa is very commonly present, and may be treated with grey powder, calomel, bismuth, etc. If it has lasted for some time, as it usually has, small doses of laudanum with dilute nitric acid are often useful. In some cases irrigation of the bowel may be indicated. If the spasms are severe chloral may be administered, preferably by the rectum. In the tetany of young children as it is seen in this country, an antirachitic regimen is nearly always indicated, including cream, cod-liver oil, hypophosphites, with fresh air and sunshine. Exposure to cold must be avoided. The cold spinal douche is of the greatest value, and should be given once or twice daily, while the child is sitting in a couple of inches of warm water so as to avoid chill. This treatment is all the more indicated if laryngismus is also present.

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Only a few of the more important references are given. A fuller bibliography will be found in Frankl-Hochwart's work, No. 3, and in Russell's paper, No. 4.

Therapeutics.

This section comprises the following three sections:—

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(*See also* BALNEOLOGY, DIET, etc.)

IT will be seen from the above that considerable space has been devoted to the consideration of the important subject of Physical Therapeutics. This subject includes the treatment usually spoken of as massage.

Unfortunately the words "massage" and "masseur" have come to bear, in this country at least, a somewhat contemptuous meaning, the cause of which is easily understood. As massage movements are quite mechanical in their application no great capacity is necessary to acquire the power of administering them. Consequently uneducated persons have been largely employed to carry out the instructions of qualified practitioners; and since knowledge of cause and effect was quite awanting in such persons, the British public has, unfortunately, learned to apply the terms "rubbing" to the process and "rubbers" to the operators.

It is quite as important in massage, as well as in medical gymnastics, that no operator who is ignorant of the quantity and quality of his manipulations with reference to effects should have charge of cases, for there is a positive danger in intrusting massage and manipulatory treatment to the "mere rubber" or bathman. That this is extensively done by the Medical Faculty in Britain is greatly to be regretted, since the numerous benefits of scientifically applied manipulations are to a large extent unknown, and by this attitude a great injustice is done both to the system and to many patients who, instead of enjoying its curative influences, may even become the victims of additional suffering. It is also regrettable that medical men have, to some degree and from want of scrutiny, shared the erroneous view of the public that therapeutic manipulations can be summed up in the word "rubbing," and that therefore they can be properly applied by the "rubber" or so-called "masseur" with a knowledge acquired in a few weeks or months.

When a medical gymnast is called in the fullest diagnosis should be furnished, to allow of his choosing the best movements and manipulations to combat the ailments under treatment, for in critical cases it may happen that if no diagnosis, or an incomplete one, be given, harmful results may follow upon the administering of certain movements which ought not to have been applied.

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Historical Note.—The Greeks, celebrated so deservedly for the stage of advancement to which they raised physical culture, laid down two axioms of their science: *first*, that health, strength, and beauty were interrelated; and, *second*, that the "*golden mean*" was the true guide to secure that triple end.

Throughout the 2000 years that have elapsed since Greek culture was at its zenith, no other nation has taken up the idea of physical culture with any degree of thoroughness till the nineteenth century, and it has been left to a northern European people to do so. Physical culture along the lines of physiological law is so peculiarly the quality of Peter Henrik Ling's work, that the words *Swedish Gymnastics* imply something which the Greek system did not possess.

Ling died in 1839, and bequeathed to his countrymen the inheritance of his exhaustive and scientific system, of which the legatees have shown themselves worthy recipients. The developments of the modern Swedish schools have confirmed the validity of the fundamentals underlying Ling's system, adding what modifications seemed necessary by the advancement of modern anatomical and physiological research.

Definition.—The word gymnastics in its present usage connotes such "*Systematically arranged exercises or manipulation of parts of the human body as shall secure the retention, preservation, and restoration of harmonious, healthy, functional activity.*"

Scope.—All true gymnastics must, therefore, be devised with strict regard to anatomical and physiological law, and with a knowledge of the effects produced by the movements and manipulations involved, and which must be chosen as the *best* means to attain the end in view. The human organism at all ages, conditions of development, and states of health, must be made the object of scientific study.

Movement in the infant is the first sign of life; and the incessant activity shown by young children points to movement being a necessity of existence.

Retention of the ideally healthful state, usually ascribed to infancy, is the first care of gymnastics.

As soon as an organ has reached the stage of mature development, movement is absolutely essential to its retention of health, for that which is not used becomes weakened and atrophied.

Exercise, far from destroying the living organism, is a sure means, not only of retaining health and strength, but of adding to the stock, provided that normal conditions as to food, clothing, ventilation, and washing exist. A true pedagogical gymnastic system will therefore follow out the natural laws of development and the innate tendencies of a healthy life.

Need for Gymnastics.—If one only spend a brief hour in observing the physique of a city crowd, he can be at once convinced of the appalling fact that anything approaching a perfectly balanced body, either in man or woman, is as rare as 1 in 100, taking the bulk as representing all ranks of society.

Flat chest, rounded back, lateral curvatures, weak ankles, stiffness, and "lack of carriage," are all so obvious, that the wonder is that any people so rigorous in its demands as to mental attainments as Europeans, should be so callous as to defects in physique.

To be physically deformed from carelessness is as great a shame as illiteracy.

The people of the British Isles have, on account of their universal love of games and sport, a very high average of physical strength and endurance, especially so in the leisured classes; even these, however, do not secure harmonious development, and some part of the system must, as a consequence, suffer for the sake of strength. What, then, can we expect of the mechanic stooping over a bench eight hours a day with a tool clenched in his hand? What of the factory operative breathing the dust arising from the material he uses? What of the miner picking coal while lying on one hip? None of them enjoying a good supply of fresh air and light, and finding relaxation only as onlookers at active games, and not as participators.

By habitual usage in daily life many muscles of the body acquire an abnormal length, either being too long or too short; and when the average man seeks a position of rest or ease, his attitude is far from graceful—his over-lengthened muscles refuse to contract fully, and his over-shortened ones refuse to fully expand again.

The bad positions occupied during work have become so ingrown through long continuance that man regards them as a necessity of his occupation, and any advice as to how he may straighten his crooked and stiffened joints will reject as unpractical.

All crooks and unnatural curvatures have, to a great extent, their origin in a permanently bad length of muscle, which is either lengthened or shortened beyond what it ought to be in a well-balanced body.

At the same time, as labour performed in awkward positions unduly lengthens some muscles, so those muscles situated on the opposite side of the trunk or limb are unduly shortened. A muscle is permanently shortened if never fully extended, and it will become permanently lengthened if it be not allowed to contract itself.

Influence of Movements upon Circulation and Circulatory Organs.[1]—Movement is followed by waste, waste demands repair. In order that the blood shall do this duty thoroughly, it must be of a certain quality and quantity, which are determined by nutrition, respiration, and circulation.

It is clear, therefore, that the chain of causation becomes a circle. Observation, too, makes it plain that the sphere of influence of each of the functions cannot be strictly demarcated since their interdependence makes the unit.

For the sake of practical results, however, this logical difficulty will be disregarded, and the influences which movements exert from the various functions will be considered.

Every movement, however insignificant, brings about chemical change. The waste matter finds its way into the venous system and is conveyed to the lungs, there to be oxidised. Obviously, then, if circulation is brisk and the blood be well oxidised, repair will keep well ahead of waste.

Whether in repose or activity there is a constant exhalation of carbon-dioxide and a constant absorption of oxygen going on in a muscle; and this reaction is twice as strong in activity as in repose. To preserve health there must always be a supply of oxygen equal to the demand.

By the act of contraction a muscle compresses the veins within and near itself; and these, from their internal valvular construction, admit only of a blood-flow towards the heart. The arteries, however, with their firm, strong, and elastic walls, are little affected within the muscle itself by the act of contraction; but the veins are partially depleted, and since no back-flow is possible in them a forward flow ensues. Repetition of the action causes a repetition of this increased venous flow towards the heart. *It is the scientific application of this fact to medical gymnastic movements which makes the basis of treatment of diseases of the heart and circulation.*

When muscular contraction is over the veins containing less than their full complement of blood exert a suctional pull in the capillaries, and the push from the arterial side augmenting this pull, a much accelerated flow, both from and to the muscle in question, aids in an acceleration both from and to the heart.

During contraction and expansion the vessels are alternately shortened and lengthened; and as veins, when moderately extended, can hold more blood than when contracted, another factor towards increased circulation is added. In proportion, then, as the movement involves a larger number of muscles, so the sum total of result is proportionally augmented. Still further, repetition of muscular contraction and expansion on a larger scale keeps a regular and large supply of blood mechanically propelled towards the heart, and conseqently by *vis a tergo* affects the flow of arterial blood.

Not only are exercises devised for the purpose of relieving the heart of strain, but it is also possible to affect the blood-supply in any part of the body by the same means—to diminish it or increase it according to the nature of the movement or manipulation employed.

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[1] With the movements described as suitable for diseases of the heart and circulation, there is frequently combined treatment by artificially prepared baths on the well-known Nauheim principle. The undoubtedly beneficial results derived from this treatment are believed to be dependent on peripheral stimulation of the skin by the mineral and gaseous ingredients of the bath. The chemical ingredients used are—chloride of calcium to stimulate the skin, and hydrochloric acid and bicarbonate of soda to generate the carbonic acid effusion. The initial strength of chloride of calcium is 0·2 per cent, gradually increasing to 0·5 per cent. Various degrees of effervescence are employed. The strengths recommended by Bezly Thorne are: mild, ½ lb. $NaHCO_3$ to ¾ lb. HCl; medium, 1 lb. $NaHCO_3$ to 1½ lb. HCl; strong, 2 lbs. $NaHCO_3$ to 3 lbs. HCl. Bath treatment should only be undertaken by a medical man who has had experience of the treatment. While undoubtedly very great benefit is obtained in some cases by this treatment, it is by no means easy to determine how much is to be attributed to the effects of the bath, and how much to the resistance exercises that accompany it.—(Ed.)

In the case of patients who are unable to take the necessary amount of exercises to accelerate circulation, and in heart disease cases where it is desired to increase circulation and diminish heart strain, what are defined below as *passive movements* may be administered. *E.g.*, where the muscle is kneaded between the hands of an operator the blood is squeezed out of the veins towards the heart, and so the same effect is produced as in an active movement performed by the patient himself.

Again, as in the case of Rollings (*q.v.* Movements below), the alternate elongation and shortening of the numerous veins that pass the joint take place. Each time the lengthening occurs the blood is sucked up from veins situated near the surface, and these in turn act as a drain upon the capillary area, which they influence.

Immediately after the shortening the contents of these vessels are impelled towards the heart, and so on, the oftener the action is repeated the stronger and more lasting will be the effect.

It will thus be seen that movements systematised for their specific effects may be employed therapeutically, not only in regard to circulatory weakness in regions remote from the centre, but in the heart itself.

Influence of Movement on Respiration and Respiratory Organs.—It has been noted under Circulation that increased supplies of oxidised blood are carried towards the part affected by movement; but oxidisation must keep pace with the waste. The lungs, therefore, whose duty it is to carry out this process, must be capable of adapting themselves quickly to increased action. A powerful respiration is a most important factor in this process, and unless the chest be cultivated, so as to allow of inspiration and expiration being of the fullest nature, and so that its mobility will answer the demand for a quick supply of air when heavier exertion is engaged in, the waste products will accumulate more rapidly than they are oxidised, and disease ensue.

The mobility of the thorax does not only depend upon the mobility of the individual ribs in their joints with the dorsal vertebræ, but also upon the reciprocal mobility of the vertebræ, for the ribs must follow the vertebræ to which they are attached. If, therefore, the dorsal vertebræ are carried forward by the rounding of the back, the ribs are consequently lowered, and if the dorsal vertebræ are carried into a correct standing position the ribs are lifted. It is the duty of every one to keep the machinery for carrying out the work of respiration in as good working order as possible. And although the act of respiration goes on when the body is in an unconscious state (showing that to a large extent it is independent of the will), yet conscious effort plays a great part in determining whether the movement shall be of the healthful maximum or the disease producing minimum.

Clearly, then, the whole thoracic apparatus, muscles and joints alike, must be well exercised throughout their entire range of extensibility and contractibility to secure the best possible state of health. And this can be accomplished by carefully arranged exercisings only.

Inspiration which is not full, but short, and so superficial, leaves certain lung areas unexercised, *e.g.* the apices, and so vulnerable to disease, reduces the proper medium length of some muscles and increases that of others, destroys the æsthetic beauty of the body, obstructs the fullest oxidisation of the venous blood, and impairs the health generally.

It seems almost needless reiteration to remind any one of the necessity of practising the art of breathing. Take, however, a practical test. Let say a dozen men of forty take part in some exercise where the whole of the body is brought into play. Most of them will speedily show signs of distressed breathing. This breathlessness is remediable, and is caused by the want of flexibility in the muscles involved in the respiratory act.

To develop a flexible chest is of the greatest importance, especially in childhood, and then it is most easily attained and retained, since the muscular pliability is greater than in adolescence. Anything which militates against full chest expansion is injurious to health; hence tight clothing round chest or abdomen, corsets in particular, deserve the most stringent condemnation; parents, therefore, and others in charge of youth cannot be too careful or too watchful against these insidious enemies of health.

Respiratory exercises must be regarded of the highest importance in a true gymnastic system; and in movements (performed *by* the subject, or *upon* him by an operator) intended to influence the respiratory organs, expiration and inspiration have their proper times of incidence at which they will *aid* the process, but if not occurring at the exact periods in the course of the movement they will do no good, and sometimes do harm—*e.g.* exercises compressing the chest during inspiration.

When the back and neck are kept straight, the head erect, chin drawn in and the chest generally elevated, the inspirations are obviously deep; the oxidisation of the venous blood is more thorough, and pulmonary circulation accelerated. All movements performed in work, play, or exercise, which further these results tend to augment the health. In patients, however, these cannot always take place save as passive movements, but the intelligent operator does his best to make the atrophied or diseased parts carry out the functions of a healthy life.

Influence of Movements upon Digestion and Digestive Organs.—It is clear, however, that even though the blood is well oxidised by thorough respiration, and circulation be active enough, the system may show signs of fatigue from which rest alone cannot recover it. The carbonaceous ingredients of the blood may not be abundant enough to supply the waste going on in the tissues, or other chemical properties may be lacking, and consequently the balance between nutrition and attrition is destroyed.

This may be due to lack of food, or, when food is abundant enough, to the wrong kind of food; or even when the food is of good quantity and quality, yet the state in which it is presented to the body will not admit of the alimentary system making use of it.

The saliva, gastric juice, and intestinal secretions all involved in the chemical process of digestion may not receive the necessary aid from the teeth, the muscular parts of the stomach and abdomen, and the peristaltic action of the intestines themselves.

The flattening and up-curving of the diaphragm following upon inspiration and expiration act as a pumping from above upon the abdominal and pelvic vessels, not only accelerating the circulation, but, of greater importance, influencing peristalsis through the involuntary muscles of the intestines. A still stronger effect, however, can be produced by such active exercises as call the whole of the abdominal muscles into play. In treatment for diseases of the digestive organs, where manipulation is directly applied to stomach or intestines, the strongest possible aids to digestion are given. And while the benefits vary in ascending degree as written above, they are all induced by the movements referred to.

The mechanical movements directly applied to the various organs strengthen the various muscles involved, attract a stronger blood-supply to the part operated upon, exhilarate secretions, and so increase both the mechanical and the chemical reactions in the digestive process. But the benefits do not end here, for in certain manipulations, for instance the rolling from side to side of the whole abdominal contents (abdominal kneadings), secures a more complete commingling of the food in the intestines generally, inciting a complete exosmosis of the nutritive properties of the food, and a speedier evacuation of the fæces.

Strong abdominal muscles are a sign of good digestion, and whatever exercises or passive movements tend to strengthen these muscles, or to promote the activity of the digestive processes, obviously benefit health. The fuller secretions of the mucous membrane of the stomach and intestines, incited by exercise, either active or passive, give at once to the system a feeling of health and buoyancy the reverse of what is felt in indigestion. And the powerful influence of direct manipulation in certain diseases of the digestive organs is demonstrated by the efficacy of stomach shaking, abdominal kneadings, and similar forms of treatment more fully considered under movements. The unhealthy accumulation of mucus on the surface of the membrane of the digestive organs is readily removed by the same class of movements. Occasionally a complication may be met, when heart disease with valvular lesions is followed by a venous congestion in the digestive system, but even in such cases abdominal kneadings have a very beneficial effect, not only on digestion, but also on circulation and the heart itself.

Influence of Movements on Secretions and Excretions.—General observation and what has been stated above in "circulation" and "digestion" proves the power of movement to accelerate and augment the blood-flow. By increased pressure of the blood the phenomena of endosmosis and exosmosis and the flow of the lymph are much accelerated. And just as the alternate contraction and expansion of muscles cause an increased flow towards the heart of the blood in the veins, so too do they propel heartwards the flow in the lymphatics.

The influence of full and strong respiration on the thoracic duct is very marked; suction is set up in it by deep inspiration, which accelerates its flow; and compression follows upon exhalation, which in turn forces the contents of the duct into the venous system.

In the skin the proofs of the influence of movements are readily noticed. The flushing in a part exercised and the increase of perspiration soon follow on rapid or energetic action. And the fact that excretion shows itself thus is a demand on the part of nature for the keeping open of the pores—not only to remove the excreting products normally removed by the skin, but also to regulate the temperature of the body.

The full activity of the kidneys, liver, and other pelvic organs is a necessity of health and even life itself, and the balance between waste and repair in the bodily economy can only be preserved when the organs involved in the scavenging of the body perform their several functions fully and regularly.

The direct removal of the fæces will be frequently referred to as an effect aided by abdominal, intestinal, and other movements below; but kidney and liver activity also are both promoted by trunk flexions and rollings.

The more the body is trained by gymnastics to minimise the degree of fluctuation from the normal in pulse, temperature, waste, and repair, the more nearly perfect will the heart be.

Influence of Movements on the Nervous and Mental System.—Men accustomed to hard open-air work, and those whose bodies are toned with sporting pursuits or gymnastics, are seldom troubled with what in common parlance is called "nerves." On the other hand, those whose motor nerves are insufficiently exercised not only lose power of motive action, but also lose the inclination to take that exercise which would be medicine to their bodies. The loss of will power in the direction of physical activity is the direct consequence of weakness in the motor-nervous system. Similarly, those who cultivate the physical side with a disregard for mental qualities are usually characterised by want of initiative and lack of control. This briefly means that balance between the sensory and the motor system has been lost. Persons of sedentary habits are frequently the victims of want of balance; and the strenuous brain activity of those who determine to excel in the mental sphere of labour is frequently the direst enemy of their success.

By the practice of active exercises the cerebral influence upon the parts brought into play is gradually increased. So that not only is any part once exercised more capable of responding to further mental stimuli, but the brain centres connected with these parts increase both in readiness and power to act.

It is a common fact that many nervous disorders arise from a want of physical labour or other exercises. A supersensitiveness both to internal and external stimuli manifests itself in "jumping" at slight sounds, objections to an ordinary degree of light, headache, neuralgia, cardialgia, palpitation, and hysteria in general. Frequently, too, the opposite may be the symptoms of nervous disorder—a passivity and inattention to general stimuli.

Thus both abnormal irritability or weakness and numbness are alike signs of this disease; and not only does this apply in reference to movements, but also to the other functional activities of the body.

Morbidness, shyness, and moping are by no means the mark of the athlete; and to give an all-round bodily development to the victims of these symptoms is to make a normal and healthy man out of a puling and unmanly nature. It is the want of appropriate bodily exercises which is the cause of many nervous disorders; and probably in no sphere is this more emphasised than in our modern school life, where there is a tendency to sacrifice physical culture to mental attainments.

As the brain is the chief organ of the mental powers, a constant supply of nutritive and well-oxidised blood is essential to the preservation of the physical condition of intellectual activity; and as the dependence of this blood-supply upon digestion and respiration is very close it follows, from what has been shown as the benefits of movements upon the physique in general, that a good brain is better served by a sound body than by a weak and neurotic one. Perhaps no better coadjutor of an active intellect can be found than the spade; and no better antidote to the excessive supply of animal strength than a constant and moderate line of activity for the powers of thought and will.

The multitude of small dangers to which the bodily economy is daily subjected is more readily overcome by the physique accustomed to activity than that which is rendered flabby by sedentary occupations. For man has in his own organic structure a potent and sufficient means of health preservation, and for the combating of disease, provided that he has the knowledge of the mode of putting these into action, and the cultivated will power of a balanced mind.

THE length of a muscle, when it is not influenced by the will, but is quite inactive, is called "*the medium length.*" Though the muscle be inactive in its medium length, it is not therefore slack, but resembles an elastic band fastened at both ends, and so slightly extended that no spring of any force would result from its being freed at one of these ends.

This tension (*tonos*) in inactive muscles shows itself plainly when, for instance, the tendon of a muscle is severed through accident. The muscle contracts, and separates slightly from its tendon.

It is essential to a proper appreciation of the test of muscular efficiency (viz. harmonious development), that the meaning of *medium length* be clearly understood. Of course there can be a wrong medium length, *e.g.* in a lopsidedly developed person; but to restore all muscles to a *proper medium length*, measured by the test quoted above, is the aim of preservative gymnastics.

Throughout the human organism there exists a universal duality between physical and mental, sensory and motor systems, waste and repair; and so soon as the balance between these is destroyed ill-health and disease find a footing. Gymnastics must, therefore, seek the preservation of ideal health throughout the period of manhood, acting counter to all abnormal developments, and preparing the organism to take up the evolving functions imposed upon it.

As in mechanics every stress has its strain, so every flexor muscle group has its extensor group; and it is a fact provable by observation, that the farther we go from childhood, and the harder the labour undergone in doing so, the farther do we recede from the ideal health and beauty. The flexor muscles are rarely or never fully extended, and consequently the extensor muscles never fully contracted, in the operations of daily work; and thus they gradually become diminished in their power and range of action, and as a result a false medium length is habituated. Crooks, stiffness, and general lack of grace ensue, and only by systematically arranged exercising can the flexors and extensors be made equally long and equally strong, the power of fully extending or fully contracting the muscles be regained, and the "*proper medium length*" restored.

The most telling external sign of an harmonious development is "*a good carriage*," and this is the immediate result of exercises mentioned above, *e.g.* flexibility in the hip-joint is a *sine qua non* of a good carriage. The effects of special exercises for this joint are somewhat complex.

When the body is bent forward, with the back straightened, the pelvis goes along with it, and the os ischium is swung upwards. The limit of this action is determined by the range of operations of the three muscles, viz. 1, musculus biceps femoris; 2, musculus semi-tendinosus; 3, musculus semi-membranosus, commonly called the ham-string muscles, which extend downwards from the hip-bone, past the knee, to the upper part of the lower leg. The tendons of these muscles may be felt behind the knee. Besides turning the pelvis in the hip-joint these muscles bend the knee, and if their medium length be too short (*i.e.* they are too tight and cannot be stretched far enough), they keep down the hip-bone and prevent the pelvis from turning forward. And if in spite of this the body must be bent, then as the loins cannot give way the back is rounded.

Keeping the knee-joints bent, a very common practice in sleep, invariable in sitting, and too common in standing, gradually deprives these muscles of their power of full extension, and as a consequence not only is the back rounded, as stated above, but the waist is drawn up, the chest contracted, the organs of respiration, circulation, and digestion compressed, and the seeds of disease sown in a system already seriously enough marred by its loss of æsthetic beauty.

Systematic exercises are, therefore, a corrective of the bad habitual positions assumed in daily life, and their operation helps to restore the balance which the system has lost from strain. Indeed they are a form of *rest,* for it is a false notion which describes rest as inactivity.

Movements

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Apparatus and Terminology

The only apparatus requiring explanation are certain articles which cannot be named by an English equivalent. These are boom, peg-post, and plinth.

Boom is a horizontal bar, adjustable to height, and fixed between two uprights.

Peg-post, a construction consisting of a firm wooden upright, with pegs of a foot to a foot and a half long fixed transversely to this. If, for example, the rungs of a ladder were projecting on either side of one stay, instead of being held by two, a peg-post would be the result.

Plinth.—Of this article there are two heights, the high plinth and the low plinth. The high plinth is a long stool (say six feet) with four legs, which are fixed to a platform which stands 9″ or so from the ground, and which projects, say, 9″ on either side of the stool legs. The stool is in half its length narrow enough to be conveniently bestridden by children, and in the other half wider for adults. Leather loops are attached to the platform below, like stirrups, into which the feet of a patient can be thrust. The low plinth is a four-legged stool about six feet in length, the top of which is padded, and is divided into two sections at about $\frac{1}{4}$ and $\frac{3}{4}$ of its length from the ends. Both sections work on hinges where they meet, the shorter forming "the seat" and the longer "the back." Both can be fixed at varying angles by means of an easel-leg underneath working in a ratchet. The back can assume an angle of 90° at a maximum and 30° at a minimum, and, of course, moves then to the horizontal, while the seat can be fixed at about 45°, 30°, 15°, and the horizontal.

The *terminology* of Swedish gymnastics is stereotyped, succinct, and, after a little study, both useful and self-explanatory. The common terms used in this article are explained in alphabetical order below for convenient reference. *E.g.* in applying this, say the order "Stretch-grasp-standing" is given. The last word shows it comes under the group derived from fundamental standing (*q.v.* below).

"Stretch" always means that arms are extended upwards at the width of the shoulders.

"Grasp" means that the hands clasp either a bar or other support.

By adding the three together the full position is clear.

Double means that the movement is similarly applied to both arms or both legs at the same time.

Grasp is applied only to the hands, and the patient takes hold of some support, perhaps the operator's hands.

Half (*v.* double) refers to one arm or one leg at a time.

Heave has three meanings: (1) It is applied to the movement of the arms from the sides into a horizontal sidewards position, or a forward upward movement whereby "stretch" is reached (*v.* stretch); (2) When the patient grasps a horizontal or two vertical bars or other apparatus, and by bending the arms draws himself from the ground, he is said to "heave"; (3) When he rises on his toes the movement is called heel-heaving.

Hips-firm refers to the position of the arms. The hands grasp above the hipbones, thumbs backward, and fingers in front.

When "hip" is used instead of "hips" one hand only is referred to.

High, when connected with "grasp," refers to the position of the hands with relation to the head, *i.e.* above it.

When connected with "ride," refers to a height sufficient to clear the feet from the ground (*v.* ride).

Lean indicates that some part of the body, *e.g.* hands, legs, arms, hip, side, or back, takes support against some stable object.

Neck-firm indicates that the hands clasp on the nape of the neck. When one hand is meant, "right or left neck-firm" is ordered.

Reach means that the arms are fully stretched out in front horizontally, and at shoulder width, the palms inwards.

Ride is the position of sitting as in the saddle, upon the plinth or other suitable apparatus. When combined with "high" the feet are on the platform of the plinth and the toes in the "stirrups."

Stoop.—The trunk is bent forward by flexion in the hip-joint.

Stretch refers to the hands and arms, which are raised full length above the shoulders, palms facing inwards.

Stride means that from the fundamental standing position, or other position, the feet are carried apart sidewards twice the length of the foot.

Yard (from ship's yards).—The arms are stretched outwards to the side in a horizontal position and carried slightly backwards, palms facing the ground.

Movements

All gymnastic treatment, whatever its aim, makes use of movements; and these the founder of the modern system of Therapeutic Gymnastics (P. H. Ling) classifies into three groups: (1) Active, (2) Passive, (3) Duplicate. In his theory he states that as life consists in a blending together of three elements,—dynamic, chemical, and mechanical,—so disease consists in a lack of any one of these elements; and the cure of disease must be chosen of the same quality as that which is lacking.

(1) *An active movement* is one which the patient performs alone, and includes the instruction given to classes and individuals under the name of pedagogical gymnastics, which movements are sometimes employed for a special purpose in medical treatment.

(2) *A passive movement* means the manipulation of or upon any part of a patient's body, the operator alone being active, the patient strictly passive.

(3) *A duplicate movement*, or *movement with resistance*, is one where the activity is shared by both patient and operator.

(*a*) When the patient moves a part of his body against resistance applied to the same by the operator, the movement is termed *duplicate concentric* or shortening movement.

(*b*) When, however, the operator moves the limb accompanied by resistance on the part of the patient, the movement is called *duplicate eccentric* or lengthening movement.

The movements under (2) and (3) above include the bulk of the movements employed in the curative treatment of disease, and upon which attention in this article is chiefly directed.

Before going on to consider movements which are intended to have effect upon specific ailments or diseases, it will be necessary in a brief manner to explain and illustrate what are generally called *fundamental positions.* No active movement can be properly carried out without the subject taking up an absolutely correct position from which to carry out the operation; and this cannot be too strongly insisted upon.

There are four fundamental positions adopted here: (1) *Standing*, (2) *Lying*, (3) *Sitting*, and (4) *Hanging*.

(1) *The Fundamental Standing Position* (F. S. P.)

Heels touching on the same line.

Feet turned out equally, making an angle of 90°.

Knee- and *hip-joints* well stretched, but without strain.

Spine stretched as straight as its natural curvatures will allow.

Hips slightly drawn back; consequently the pelvis is carried forward and upward, the abdomen is drawn in, the thorax arched forward and expanded.

Head high on the stretched neck.

Chin drawn in and eyes taking a horizontal view.

Shoulders on the same level and drawn well backwards and downwards.

Arms extended along the sides of their own weight, palms inwards, and fingers well stretched and close to each other, touching the thighs.

The axis of gravity must pass through the ball of the foot and not the heel, which only slightly presses on the floor.

Note.—The importance of strict regard to the above detail lies in the facts that—(*a*) the chest gets free expansion from the slackness of the abdominal muscles, which, were the axis passing through the line of the heels, would draw the ribs downwards, and as a result compress the chest; (*b*) the muscles of the back are therefore employed in retaining the body in correct position, thus relieving the abdominal muscles of strain.

(2) *The Fundamental Lying Position* (F. L. P.)

The whole body lies outstretched on the back similar to above.

Legs touching each other.

Arms by the sides and palms touching thighs resting of their own weight on the support.

This position is called the rest position, and in general gives a sensation of ease and comfort to the subject, soothing the heart's action, and equalising the blood pressure throughout the system. From this position many other positions are derived suitable for various forms of treatment for delicate people.

(3) *Fundamental Sitting Position* (F. Stg. P.)

The thighs and buttocks rest on a horizontal support in height as nearly equal to that of the knees of the subject as can be got, the legs touching each other all the way down.

The important point to be observed is that the head, neck, eyes, and trunk are to be kept strictly as in the F. S. P. (No. 1 above), and the arms and hands the same, as far as the seat will allow.

(4) *Fundamental Hanging Position* (F. H. P.)

The hands grasp a horizontal support at a width at least equal to that of the shoulders—the support being at such a height above the floor as will allow the toes to be free of the floor, when the arms, trunk, and legs are fully extended.

The head may be held a little farther back than in the F. S. P. (No. 1), so as to allow the upper part of the spine to form a slight arch forward.

The other parts assume the F. S. P. as closely as possible.

Special attention should be paid to obviate the contraction of any of the muscles in front, so avoiding rounding of the shoulders. Too strict care in observing these details cannot be enforced, as by neglect of even some slight injunction the whole purpose of the operation may be stultified and even positive harm brought about.

From these fundamental positions many derived positions are obtained by moving the head, or trunk, or limbs, or by combinations of these, while the other parts retain, without material change, their original postures. It is not within the scope of this article to give full detail of all derivatives, such being explained as occur in the course of disease treatments and other principal groups of the system; for fuller information a text-book of Swedish Medical Gymnastics may be consulted. When explanation is not given below it is understood that the terminology will make all clear. The positions given below are grouped under the fundamentals from which they are respectively derived.

I. *Positions derived from F. S. P.*

A. *By moving lower extremities.*

(*a*) In "*close standing*" the feet are turned inwards, touching each other, all the other parts as F. S. P. (*b*) *Toe-standing;* the heels are lifted from the ground and the body supported on tip-toe. (*c*) *Knee-bend-toe-standing;* the knees are bent until they are at right angles—from (*b*) above. (*d*) *Stride-standing.* (*e*) *Half-hook-standing;* the thigh is raised to the horizontal, while the lower leg hangs at right angles, the toe being pointed to the ground.

B. *By moving the arms.*

(*a*) *Bend-standing;* the upper arms are bent and the fingers touch the points of the shoulders, which are well drawn back; the elbows touch the sides. (*b*) *Hips-firm-standing.* (*c*) *Neck-firm-standing.* (*d*) *Stretch-standing.* (*e*) *Yard-standing.* (*f*) *Reach-standing.* (*g*) *Crutch-standing;* in this case one arm is put over a bar and support is received in the arm-pit. (*h*) *Arm-lean-standing;* the arms go out in front and rest on a wall or other support. (*i*) *Yard-grasp-standing.* (*j*) *Reach-grasp-standing.* (*k*) *Stretch-grasp-standing.*

C. *By moving the trunk.*

(*a*) *Hips-firm-backward-bend-standing.*—The trunk is slightly arched backward, each vertebra taking part in succession from cervix down; very little bending takes place in the lumbar region. (*b*) *Hips-firm-stoop-bending.* The spine may be arched or the whole movement may be done in the hip-joint. Cf. remark about converse action of spine in (*a*). (*c*) *Side-bend-standing.* The whole spine should be curved sidewards, the body being kept in the same plane as while standing; guard against torsion in the vertebræ. (*d*) *Leg-lean-standing*; the bar touches the thigh in front. Varieties: left or right-side-lean-standing. (*e*) *Twist-standing;* the body is rotated to right or left, the feet and legs remaining stationary; head and neck keeping same relation to the body.

II. *From Fundamental Lying Position.*

A. *By moving the trunk.*

(*a*) *Half-lying;* the patient sits on a low plinth with movable back, which is set at 45° or so from the horizontal and reclines; the feet and legs may also be supported in front on a low stool. (*b*) *Hook-half-lying* differs from (*a*) in that the patient draws up his legs to make right angles at the knees, the heels resting on the stool. Or the seat may be movable on a hinge, and by it being bent upwards under the knees the abdominal muscles may be quite relaxed; the heels resting on the stool as before. (*c*) *Forward-lying;* the patient lies prone on the plinth with a cushion under his arms, which are crossed under the chin. (*d*) *Stretch-forward-lying.* (*e*) *Leg-forward-lying;* the limbs only are on the plinth, the body being supported by the legs being strapped in position or held down by an operator (*v.* Fig. 17). (*f*) *Side-lying;* the patient lies on either hip, the upper leg will only touch the plinth with the part below the knee. (*g*) In *leg-side-lying* the legs only rest on the support, the body being poised by strap or operator (*v.* (*e*) and (*f*) above).

B. *By moving the limbs.*

(*a*) *Sit-lying;* the whole back rests on the plinth; the legs from the knee down hang over the end of the plinth. (*b*) *Hips-firm-sit-lying.* (*c*) *Stretch-sit-lying.* (*d*) *Hips-firm-lying.* (*e*) *Neck-firm-lying.* (*f*) *Stretch-lying.* (*g*) *Stride-lying* (*v.* Terminology). (*h*) *Hook-lying;* the legs are drawn up to an acute angle, the knees being closed.

III. *Positions derived from F. Stg. P.*

A. *By moving the lower extremities.*

(*a*) *Long-sitting;* the whole leg touches the support. (*b*) *Half-sitting;* the patient stands and puts his knee over a bar making a right angle at the knee. (*c*) *Stride-sitting* (*v.* Terminology). (*d*) *Ride-sitting.*

B. *By moving the upper extremities.*

(*a*) *Stretch-sitting.* (*b*) *Hips-firm-sitting.* (*c*) *Neck-firm-sitting.* (*d*) *Yard-sitting.* (*e*) *Reach-sitting.* (*f*) *Arms-lean-sitting;* the arms go out in front and the hands grasp some support.

C. *By moving the trunk.*

(*a*) *Stoop-sitting.* (*b*) *Stoop-stride-sitting.* (*c*) *Twist-sitting* (*v.* twist standing above). (*d*) *Fall-sitting;* from ride or long sitting the trunk is bent backwards to any angle, or as far as the horizontal, support being given at the knees.

IV. *Positions derived from the F. H. P.*

Heave-hanging is the most important of the hanging positions, and the only one referred to below (*v.* Heave).

It may be here repeated that positions self-explanatory through the terminology are not commented on.

When taking any of the above positions derived from the fundamentals, only such parts of the body as are indicated by the order must be moved; the others must be retained with perfect accuracy in the fundamental position.

It is obvious that the act of assuming any position or passing from one to another involves movement, but this act does not constitute a strictly "gymnastic movement."

The movements given below are those commonly used in the Swedish Medical Gymnastics, and are arranged in groups according as they are cognate or complementary.

(1) FLEXION and EXTENSION, ABDUCTION and ADDUCTION, DRAWING, CARRYING, SWINGING, RAISING, FALLING, RINGING; (2) TWISTING; (3) HANGING; (4) HOLDING;

(5) Rolling; (6) Hacking, Clapping, and Beating; (7) Kneading, Sawing, and Pressing; (8) Shaking and Vibration; (9) Stroking and Friction; (10) Lifting, Expansion, and Heaving.

Group I.

A. Flexion and Extension are movements applied to the feet, legs, trunk, arms, and neck.

(i.) *Half-lying double-foot-flexion and extension.*—For position and head grips see Fig. 1. The operator sits on either side of the patient, and taking one foot on his knee, steadies the same with one hand while making the flexion and extension upwards and downwards with the other. The movement is usually performed with resistance applied by the operator, but is in certain diseases used passively.

This is used to increase mobility of the joint, strength, and circulation; it also draws blood to the feet and from the other parts.

(ii.) *High-arm lean-standing foot-flexion and extension.*—The patient stands on a stool facing the peg-post. He advances one foot to the edge of the stool to admit of its being deflected over the edge. The operator standing by steadies the leg with one hand and makes resistance, while the patient performs the movement. This is stronger than (i.) above.

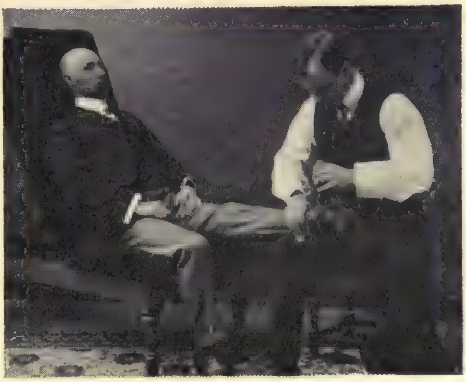

Fig. 1.—Half-lying double-foot-flexion and extension.

(iii.) *Heel-lifting* and sinking is done as a free-standing movement, and is purely active. It is usually performed as *hips-firm-standing, heel-lifting, and toe-lifting.*

(iv.) *Half-lying knee-flexion and extension.*—For position see Fig. 2. The operator sitting by either side of the patient places the upper leg of the patient on his knee, and gives resistance to both flexion and extension.

By gripping the ankle with the thumb outside and fingers in, no change save moving the hand round the joint will be required, when flexion changes to extension.

(v.) *Half-sitting knee-flexion and extension.*—The flexion and extension are performed over a boom instead of the operator's knee as above. The grips and application of resistance occur as before.

If the patient stand, say on his right foot, he raises the left leg over the boom in front of him, which is slightly higher than the knee. The legs are exercised alternately.

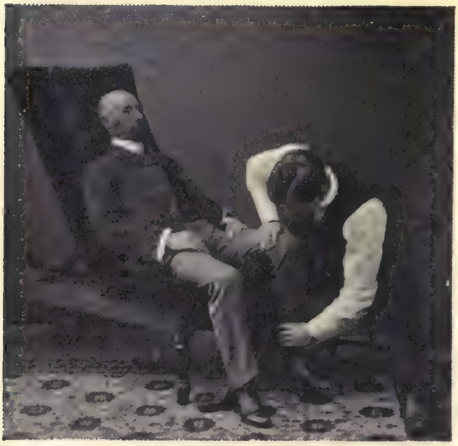

Fig. 2.—Half-lying knee-flexion and extension.

(vi.) The movement may also be performed actively in the form of *hips-firm toe-standing knee-flexion and extension;* and then the knees are bent at right angle, or even to an acute one if necessary; the body sinks while the knees bend, but remains otherwise in F. S. P.

A more powerful movement is *stretch-standing knee-flexion and extension*, but here to steady the body support is given by the operator grasping the patient's wrists.

(vii.) *Hip-joint flexion and extension* may be done in several different ways. The patient stands on a stool steadying himself by a grip on a horizontal support, and swings his leg or has it moved both forward and backward.

In the gymnastic terminology this is called high arm-lean-standing leg-swinging forward-backward.

(viii.) *Half-lying leg-flexion and extension.*—This movement is performed with resistance, as a rule, frequently accompanied by leg-rolling, using the grip in Fig. 18, all the joints of the leg being exercised. The movement is usually performed with one leg at a time.

(ix.) *Stretch-grasp-standing, knee up-drawing and down pressing.*—The patient stands with the back against a ladder, grasping one bar at full extension of the arms, and lifts his knee upwards while the operator applies resistance. The knee is now pressed down by the operator, while the patient resists.

With persons in a weak state no resistance is applied. This movement has for its object "depletion" in diseases of the abdomen, viscera, and pelvis; it is especially effective in constipation.

(x.) *Finger-flexion and extension.*—The elbow of the patient may be rested on the knee or other support; the operator, clasping the wrist with one hand, places the palm of his other upon the back of the patient's hand; both sets of fingers point upwards, each one of the patient's being in contact with a corresponding one of the operator's. The operator now presses the patient's fingers down upon the palm passively. The patient then extends his fingers, the operator resisting. When resistance to the flexion is desired the operator must change his grip, his palm facing that of the patient.

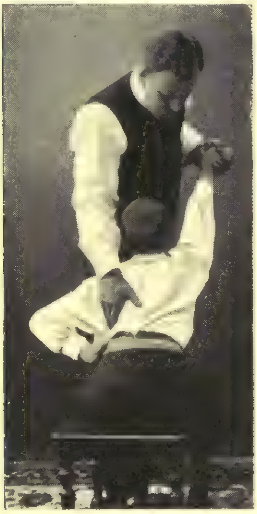

FIG. 3.—Stoop-stride-sitting (left or right) arm-extension.

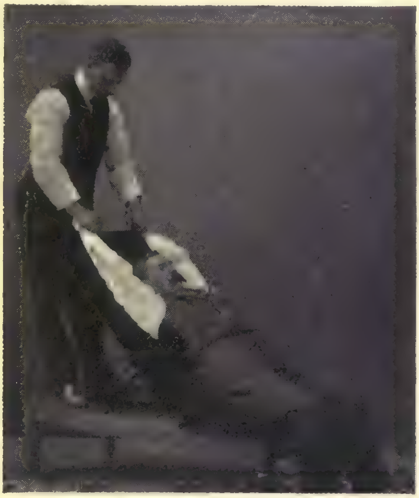

FIG. 4.—Half-lying double-arm-flexion and extension.

As variations of above each finger may be treated separately, or the thumb alone, and the other four together.

It can be done actively and passively also.

(xi.) *Wrist-flexion and extension.*—This movement may be done actively, passively, and usually with resistance. According as the direction of the movement varies—down, up, in, or out—it is called palmar, dorsal, ulnar, or radial flexion.

The best position for this exercise is to have the patient's arms lying on a table with the hand hanging over the edge; the operator grips the fore-arm with one hand and manipulates with the other.

(xii.) *Fore-arm flexion and extension.*—If specially designed to influence the elbow-joint the movement is performed passively. If the patient's left arm is being treated the operator, who is facing him, grips the thumb of that hand with his own left, palm thus facing palm. The operator's right palm is placed under the elbow-joint and acts as the fulcrum of the movement.

The patient bends or extends his arm at the elbow, acting against the resistance of the operator.

As a purely active movement it would be termed *arm or arms upward bend.*

(xiii.) *Stoop-stride-sitting (left or right) arm-extension.*—This movement is used in treating either right or left C. scoliosis. Fig. 3 shows the method.

(xiv.) *Half-lying double-arm-flexion and extension.*—From the position and grips as shown in the figure, the movement will begin by the patient bending his arms at the elbow, pulling against resistance given by the operator, who, when the flexion is complete, will give a passive pressure with vibration to the hands, causing the elbows to sink a little lower, and the arms to be pressed firmly to the sides (Fig. 4).

The extension will follow, the operator again resisting and completing the movement passively with a vibratory pull.

Throughout, the whole of the patient's arms should move in the plane of the back of the low plinth against which he is reclining, and the elbows should be well pressed to the sides.

(xv.) *Sit-lying double-arm-flexion and extension* is performed exactly as the previous, with the exception of the patient's position.

(xvi.) *Leg-forward-lying double arm-flexion and extension* is in detail the same as xiv.; (for position *v.* Terminology).

Note.—In curvature of the spine resistance for obvious reasons is administered only in the flexions (xiv.-xvi.)

(xvii.) *Trunk flexions.*—Trunk flexions are performed either forward, backward, right, or left, and are often used as *active movements* in free standing exercises.

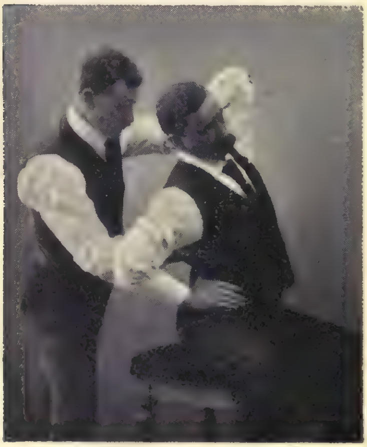

Fig. 5.—High-ride sitting side-flexion.

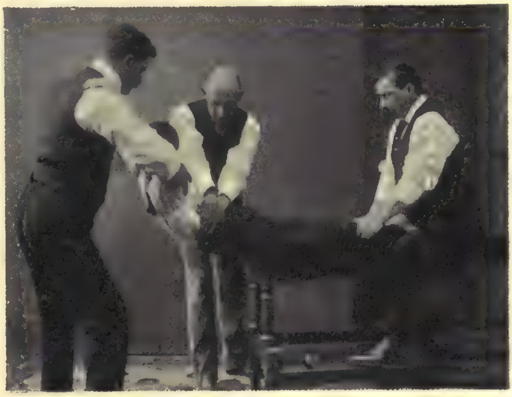

Fig. 6.—Stretch leg-forward-lying side-flexion.

The forward and backward flexions can take place in the joints of the spine, or in hip-joint, or in both simultaneously.

(*a*) *Hips-firm standing trunk-flexion forward.*—The flexion is made in the hip-joints. The whole spinal column is kept straight, and the eyes fixed on one point throughout the entire movement.

As a variation, as soon as the limit allowed by the bending hip-joint is reached, arching may be commenced in the lumbar vertebræ, continuing through the dorsal and cervical regions. The recovering movement is begun in the neck, and gradually goes downward, the hip-joint finishing the act.

(*b*) *Stretch-arm-lean-standing backward flexion with wrist support and pressure on back.*—The subject takes F. S. P., stretches both arms upwards, palms inward. Two operators stand to right and left rear, each grasping one of the subject's wrists, while each presses the free hand on the back, one superposed upon the other, and remaining so throughout the whole operation.

This movement is of especial value for "rounded shoulder." Care should be taken that the bending is not confined to the lumbar region in the backward movement.

Note.—In both forward and backward flexions the knees should be kept well straightened and the breathing normal. Beware of overdoing these exercises, as more harm than good may be easily done.

(*c*) *High-ride sitting side-flexion.*—This movement is given for scoliosis, and always with resistance; also for flattening of the chest on one side, etc.

The feet are kept fixed to the platform by straps (see Fig. 5). The operator puts one hand on the convexity of the spine and the other on the raised elbow of the subject, and gives pressure. For application of this and variation in position *v.* scoliosis.

(*d*) *Standing side-flexion at boom* has a similar object in view. But both (*c*) and (*d*) are also given as purely lateral trunk movements, and are useful for many other forms of disease.

(*e*) *Stretch leg-forward-lying side-flexion.*—For position see Fig. 6.

Two or three operators are required; instead of the third a strap can be used.

The subject has both hands on the shoulders of one operator, who moves the trunk sidewards by a grip on the subject's shoulders, against the resistance applied to the greatest convexity of the spinal curvature by the second operator. As the movement is severe frequent rests are given to the subject.

(*f*) *Forward-lying side-flexion.*—The operation is clearly indicated by the figure. This operation is of a milder form than above and fatigues the patient less. It is used exclusively for lateral curvatures (Fig. 7).

Note.—When a lateral trunk movement to benefit the abdominal and pelvic organs is required, and scoliosis is not present, the best form is *high-ride hips-firm-sitting side-flexions* left and right.

(xviii.) *Head-flexion* is always performed in the entire column of the neck, backwards, forwards, right, and left. It is an active movement in free-standing gymnastics.

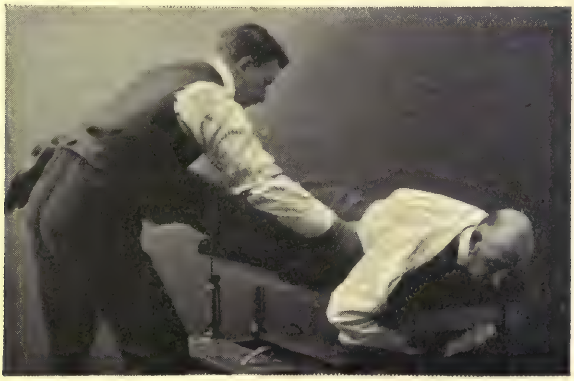

FIG. 7.—Forward-lying side-flexion.

Care must be taken that the whole cervical vertebræ are exercised, and that the movement is not confined to the atlanto-occipital joint.

Flexion sidewards should be done without twisting.

The above are, *e.g.* used *passively* for torticollis rheumatica, when the patient may sit, lie, or hang.

The various movements are as follow:—

(*a*) *Lying head-side-flexion.*—Flexion backwards is often performed with resistance, and is then called "neck-raising." Rounded-back and drooping head are usually treated in this way. The same movement is of benefit in cases of scoliosis when the intention is to stretch the entire spine.

(*b*) *Arm-lean-standing head-flexion backwards.*

(*c*) *Stretch-hanging head-flexion backwards.*

(*d*) *Stretch leg-forward-lying head-flexion backwards.* In (*b*), (*c*), and (*d*) the operator lays his outspread fingers on the back of the patient's head, and applies resistance to the backward-flexion, but no pressure when the head goes forward. The position of the patient in (*d*) may be seen in Fig. 6, with the difference that the operator in the middle is not required, and the patient's body lies straight forward, while the operator stands straight in front of him with the grip on the head instead of the shoulders.

(*e*) *Crutch-standing head-side-flexion.*—The operator guides the movement with one hand, while applying resistance with the other (Fig. 8).

The movement is used in treating cervical or cervico-dorsal scoliosis. The position is a particularly good one for securing the trunk in a steady attitude.

B. ABDUCTION AND ADDUCTION.—These movements are entirely confined to the legs, and are performed, as a rule, with resistance. Being good muscle movements these are specially advantageous in general health exercises.

(i.) *Half-lying double-leg-abduction and adduction.*—The patient takes position as stated, and two operators stand facing him, one on either side near his feet. Each operator picks up a leg, grasping it at the ankle, and, raising the same, lays it on his own bended knee.

From this derived position the movement begins thus:—The legs are drawn out sidewards horizontally, each still in contact with a leg of the operator, the patient giving resistance; the patient now closes his legs while the operators give resistance. This may be varied by the operators giving resistance to both sides of the movement. This may also be done by one operator.

In cases of paresis, *e.g.*, one leg at a time may be exercised.

(ii.) *Stretch-lying double-leg-abduction and adduction*, and

(iii.) *Stretch-hanging double-leg-abduction and adduction* are other forms of the movement; (iii.) as a very strong movement can only be given to strong patients. The former is chiefly used in general development, and the latter as a muscle movement, while at the same time it has a good effect in scoliosis by stretching the spine.

If the treatment is intended for rounded back the patient is best to hang from a ladder with his back supported against it.

(iv.) *Hook half-lying double-knee-abduction and adduction.*—The position being taken by the patient, the operator facing him lays a hand inside each knee, and presses the knees open against the patient's resistance. The knees are closed by the patient acting against the operator's resistance. For position *v.* Fig. 9.

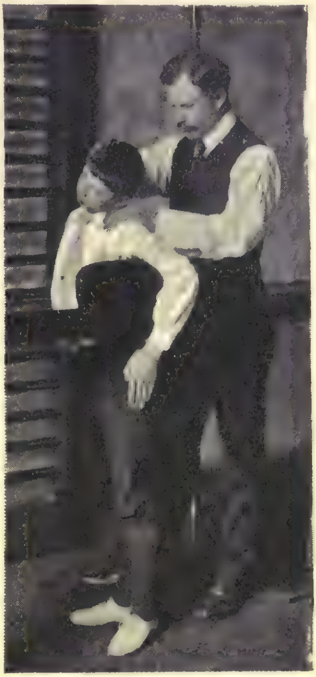
FIG. 8.—Crutch-standing head side-flexion.

The pelvic and abdominal organs are specially benefited by these movements.

C. CARRYING.—Many carryings can be done with the arms and legs, but these must be stretched so that the intermediate joints are not brought into play. The movement takes place in the shoulder and hip-joints only.

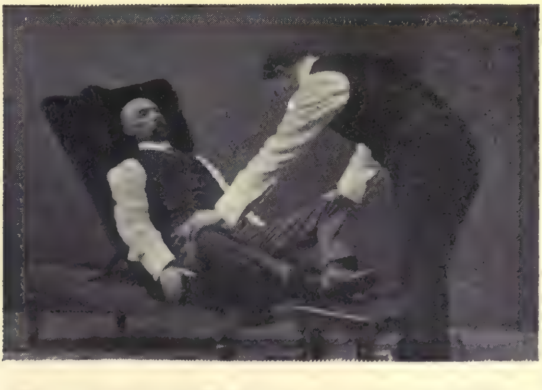
FIG. 9.—Hook-half-lying double-knee-abduction and adduction.

(i.) *Leg-lean-standing double plane-arm-carrying.*—Both arms of the subject are put into "reach-standing" position, while the operator in front takes hold of the wrists of the patient, and the arms are moved backwards by the patient against resistance, in a horizontal plane (Fig. 10). On the return movement the operator only guides the arms in the horizontal plane without giving resistance. This movement may be modified by the subject standing with his back against a wall or other vertical support, or with his body in a "leg-forward-lying" position.

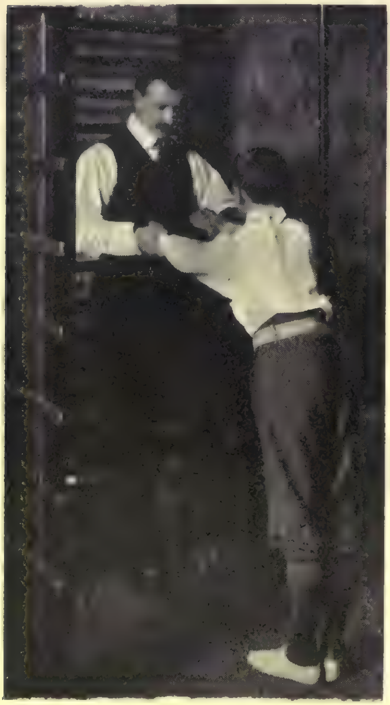

FIG. 10.—Leg-lean-standing double plane-arm carrying.

The last mentioned is a very taxing movement, and should only be given to strong patients.

Rounding of the shoulders and back and contracted chest are treated in this way. Arm-carrying is usually performed double, but leg-carrying with one leg at a time.

Leg-carrying may be done forward, backward, or sideways, either by the subject taking a hand support and an operator giving resistance, or as a free-standing movement; in which case care must be observed that the F. S. P. is properly taken before the movement begins.

As a movement with resistance, *high-arm-lean-standing leg-carrying* is one of the best, and is much used for stiffness in the hip-joint and surrounding muscles. For position *v.* Fig. 11.

D. SWINGING differs from carrying in that the parts are moved rapidly in the former and slowly in the latter; *e.g.*, arm and leg-swinging forward-backwards.

E. DRAWING.—(i.) *High arm-lean-standing leg backward-drawing.*—The patient stands on a stool, facing and grasping a support; the operator from behind grasps the leg above the ankle with one hand, keeping the other on the patient's hip, and *draws* the leg backwards, the patient resisting; on the return movement the operator applies resistance.

This is a movement specially devised for the muscles in front of the leg and the abdomen.

(ii.) *Stretch-grasp-standing forward-drawing.*—The patient stands with his back to the vertical ladder, grasping a bar in it as high as he can reach. The operator, with one hand or both hands round the back of the patient, pulls the trunk forward, the patient keeping his feet firmly on the ground. The chest is expanded while the rounded back is corrected.

F. RAISING.—By this is meant that the patient brings the trunk from a backward bend position to a sitting position, or at the other extreme from lying to a sitting position.

(i.) *Hips-firm sit-lying raising.*—The patient sits on the end of the high plinth, his legs hanging down over the end, while the operator in front presses down the knees. The trunk may be slowly moved backwards to from 135° to 180° with the thighs. The movement consists in raising

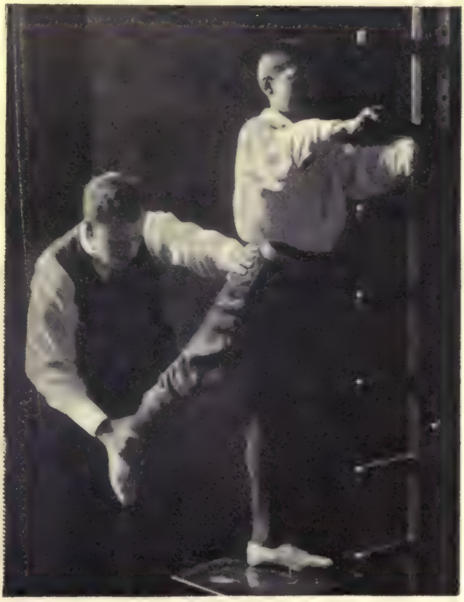

FIG. 11.—High arm-lean-standing leg backward-drawing.

the body to the vertical from any degree of backward-bending. The spine throughout its whole length should be kept straight. Many faults may arise in the performance of this movement by the neck bending, the head and shoulders being drawn forward, or one shoulder being thrown out of the level of the other, or by jerky raising.

All of these must be carefully guarded against.

The abdominal muscles are hereby cultivated and the action of the abdominal organs increased.

The movement is also beneficial for rounded back, flat chest, and a bad carriage, provided that the chest be kept well expanded, the head in straight line of the spine, and the chin and the shoulders well drawn back.

To increase the strength of the movement the arms may be changed from the "*hips-firm*" position, as in above case, to the "*neck-firm*" or "*stretch*" position, the last making the greatest demand upon the strength.

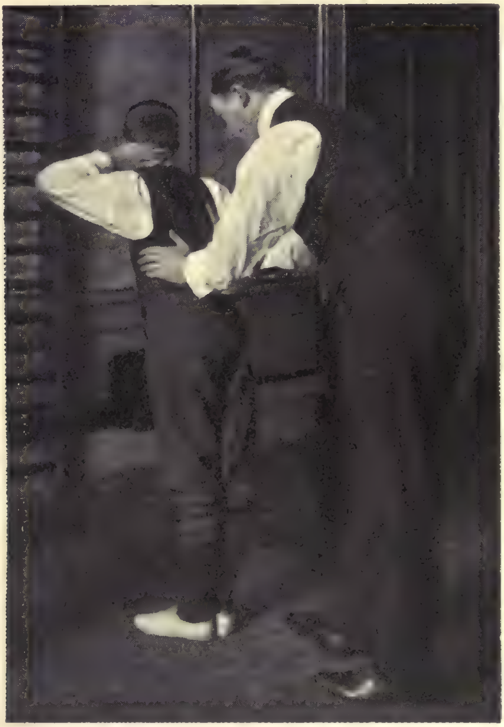

FIG. 12.—Leg-lean-standing raising with pressure on the back.

(ii.) *Leg-lean-standing raising.*—The patient stands as in Fig. 12. The operator, who sits on the opposite side of the boom on a low stool, grips the ends of a rod, which the patient also holds, and resists the patient as he raises his trunk to the F. S. P., or to "backward arching." The act of bending forward is done by the patient without resistance. The movement is a powerful one, as many of the muscles of the trunk and extremities come into play, and on this account is a good one for weak back.

(iii.) A modification of the movement is called *leg-lean-standing raising with pressure on the back*, and is specially devised for treatment of scoliosis. The operator, standing behind the subject, applies pressure with one hand on the greatest convexity of the curvature, and gives resistance to that pressure with the other, while to the raising he applies resistance with both.

A second operator is sometimes employed, who, from the front, guides the raising by pressure on the shoulders of the subject, thus securing steadiness and evenness throughout the movement.

(iv.) *Hips-firm high side-sitting raising*, and

(v.) *Stretch stoop-stride-sitting raising*, are two variations. Pressure is applied to the subject's back similarly to above if for scoliosis, otherwise the hands of the operator are laid flat on the back in applying the resistance.

In the last named the resistance is given by the operator in front grasping the patient's wrists.

(vi.) *Sitting spinal-raising upwards.*—For cases of children with abnormal spinal curvatures and weak back and bad carriage in general, this movement is specially beneficial.

The patient sits on a low stool with his hands in the groins, thumbs pointing backwards as in hips-firm. By extending his arm muscles in this position the patient causes a lifting of the trunk, which gives a powerful extension to the spine.

The operator from behind directs the movement by keeping the shoulders well back. This is the active form of the movement.

It is also performed with resistance, by the operator applying pressure in the middle of the back or on the crown of the head, downwards, which of course makes the movement much stronger.

(vii.) *Hips-firm-sitting raising with back-stroking.*—Two operators perform this movement. The patient, sitting on a low stool with hips firm, stoops forward. The operators behind and at the sides each grip one of the patient's shoulders, while the other hands are laid one upon the other between the shoulders. The patient now raises himself, the operators assisting him, with the hands on the shoulders and pressing with the other hands in a down-stroking powerful movement along the spine.

The value of the movement lies in (1) straightening the back, (2) soothing the nerves, (3) widening and straightening of the chest, (4) it is also generally beneficial for elderly and delicate patients.

The raising movement is also applied to the neck when in the forward flexion position, resistance being applied. The ordinary forms of it are—(*a*) arm-lean-standing neck-raising, (*b*) stretch-hanging neck-raising (*v.* Stretch-hanging), (*c*) stretch forward-lying neck-raising.

(viii.) *Arm-lean-standing raising with abdominal and lumbar pressing.*—This manipulation is best performed by two operators standing one on either side of the patient, who stands gripping a support about the level of the chest, the length of the arm-stretch determining the distance of the feet from the support. The arms must be fully extended during the whole movement.

One operator places a hand on the abdomen and another on the small of the back, while the other operator superposes a hand on each of these. The combination gives great strength and steadiness to the movement.

The patient now raises himself on tip-toe, bends the knees, and so lowers the trunk, which by reason of the arm-length must move slightly forward. The patient now raises himself while the operators press the front and back hands together, and give resistance during the whole raising.

Besides beneficially influencing a constipated case, many muscles are brought into play in trunk and extremities, and thus a general as well as local stimulating effect is produced. Care must be taken to confine this movement to men, or females who are generally strong, as bad effects, such as uterine prolapses, have been caused by this treatment.

G. Falling.—Falling is a term applied to the head or trunk while in the act of moving from the vertical to any intermediate position between that and the horizontal.

In trunk movements the falling may go through 90° when it gives the "lying" position; the movement is strictly a hip-joint one, and then the neck and spine should be kept strictly in one line, as in F. Stg. P., and the shoulders kept well back. It will be seen that fallings and raisings are practically forms of flexion and extension, and complementary of each other.

Many fallings may be done by the head in the forward, backward, or sideward direction.

The best form of trunk-falling is *hips-firm high-ride-sitting backward falling.* The patient bestrides the high plinth, placing his toes in the stirrups, and for steadiness having a binding strap round his knees. The body is allowed to descend slowly with the spine in a straight line. The operator judges of the angle through which the patient may go, and will assist weaker persons in the raising act. The movement is a strong abdominal exercise.

"Neck-firm" or "stretch" will give still stronger strains upon the patient (see Fig. 13).

H. Ringing.—This is always performed passively, and is prescribed as a beneficial movement in insomnia.

(i.) *Hips-firm high-ride-sitting side ringing.*—The position of the patient is exactly as in the preceding movement. Two operators stand, one on either side of the patient and facing each other; one places the right hand and the other the left on the top of the patient's right and left shoulders respectively, so that the fingers lie in front while the thumb lies behind the shoulder. The disengaged hands are superposed one above the other between the shoulder blades of the patient, and from this position the movement begins. This resembles the side-flexion, save that, while that is a slow movement, this is a very rapid movement.

The quick flexion is made to left and then to right from six to eight times, when a pause is given. These may be all repeated three or four times.

It is obvious that the movement cannot be properly performed unless the operators have good firm grips to start with, and unless the patient observe complete passivity, or at least do not impede the movement.

By alteration of the position of the hands from between the shoulder blades to the back of the head the operators may perform the movement backwards and forwards.

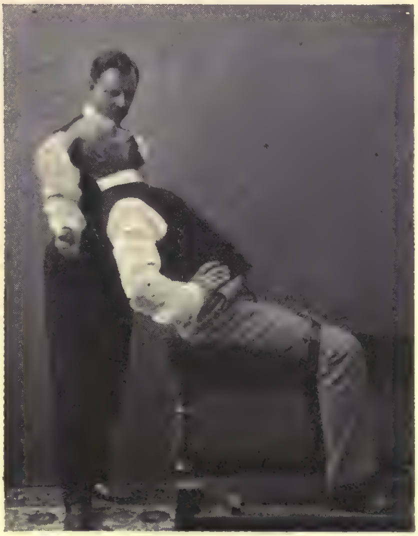

FIG. 13.—Hip-firm high-ride-sitting backward falling.

(ii.) The variation of the side-ringing when one operator only is obtainable, is in the hands of an efficient performer even more powerful than where two are employed.

The patient sits as before. The operator stands behind, passes his left hand under the patient's left arm-pit, and gripping the shoulder in front and above; similarly with right hand.

The patient's back and the operator's chest will be in contact, and the steadiness of the "rockings" from side to side perfect, and carried out with much less trouble on the operator's part. As mentioned before great importance attaches to passivity on the part of the patient.

Group II.

TWISTING OR ROTATION.—Twisting or rotation is a movement usually performed with resistance or passively, although in pedagogical gymnastics the active form is also employed.

(i.) *Head rotation.*—This movement is performed in all the cervical vertebræ and the atlanto-occipital joint; it may be done in any of the four fundamental and some of the derived positions (Fig. 14). It is a passive and also a duplicate movement in medical gymnastics. As a passive movement rotation like flexion (*q.v.*) when applied to the head is best done in the lying position, as in the figure.

The operator places a palm over each ear, and when coming to the limit of the rotation accompanies his movement with vibration; this, *e.g.* in rheumatica torticollis, when the muscles are stiffened, prevents or minimises the pain which may be caused by the rotation.

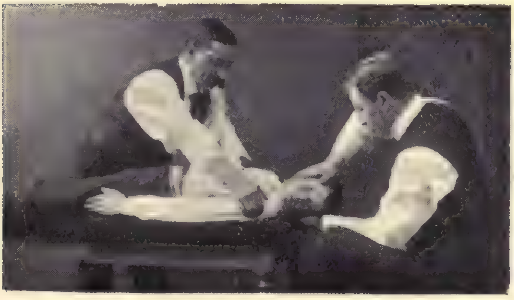

FIG. 14.—Head-rotation.

(ii.) *Trunk-rotations* are three in number, and are called (*a*) alternate-twisting or rotation, (*b*) plane-twisting or rotation, (*c*) arch-twisting or rotation; these are progressively stronger, and are always given with resistance.

They all have a powerful influence on the abdominal muscles and the digestion, as well as tending to expand the chest.

Alternate-twisting is performed in a variety of positions; those of greatest importance are here given.

(*a* 1) *Hips-firm high-ride-sitting alternate-twisting.*—The position shown in Fig. 15 indicates the fixing of the pelvis and legs, which limits the operation to the trunk. When the twisting is to the left the operator's left hand is placed on the back of the patient's left shoulder, the right hand over in front of the right shoulder. The operator gives resistance as far as the patient can twist, then changes the position of his hands and completes the movement passively. The hands are used in the opposite way on the right side.

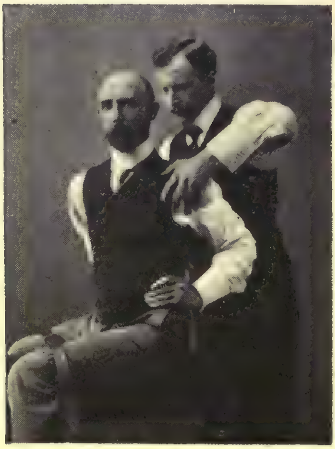

Fig. 15.—Hips-firm high-ride-sitting alternate-twisting.

(*a* 2) *Stretch-grasp-standing hip-alternate twisting.*—The patient stands between two uprights which he grasps as stated. The hands and feet remaining stationary, the rotation must be performed by the hip taking the lead, but must as a consequence affect the whole side of the trunk and arm above this, as well as the leg below.

The operator stands behind placing a hand on a hip on either side, wherever he can get a good hold, and applies resistance.

(*a* 3) *Hips-firm-kneeling alternate-twisting.*—The patient kneels upon a low plinth in the stated posture, while the operator, taking up a position from behind, raises his foot and sets it on the plinth between the feet of the patient, and so that his knee will support the back of the patient between the hips. The hands of the operator and the method of rotating may follow (*a* 1) above, *q.v.*; or the hands may be placed over in front of the shoulders, in which case resistance is one-sided, and the vibration which may conclude the movement not so powerful.

This movement is a very powerful one, especially for the abdominal muscles and the pelvic organs, but on account of its strength must not be given to weak persons.

(*b*) *Hips-firm ride-sitting plane-twisting.*—The direction of the first part of the movement on the part of the patient is a combined falling backwards with a twisting sidewards, and the recovering movement is a combined twisting and raising (Fig. 16).

The operator stands behind and grips as shown in the figure, and must be very careful to give resistance against the trunk and not against the patient's arm.

The grip of the operator's left arm, as shown in the figure, has to be taken with extreme care: the grip on the right shoulder is the same as in (*a* 1) above. As the movement is a strong one only fairly healthy and strong persons should be put through it, and even those only for from six to eight times to each side.

(*c* 1) *High ride-sitting arch-twisting.*—This movement resembles "plane-twisting" above, in that it is a combination of twisting and raising or twisting and falling.

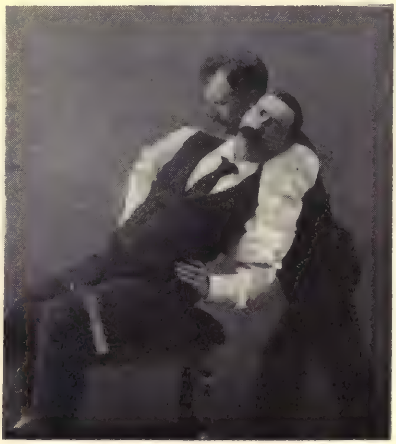

Fig. 16.—Hips-firm ride-sitting plane-twisting.

The operator stands behind the subject, whose body is supported on the operator's chest and shoulder. If the movement is first to be made towards the left the operator faces left, grasping the fully extended left arm of the patient by the wrist in an upwards backwards direction. The operator's upper right arm lies across the patient's back about the shoulder blades, while his right hand reaches to near the arm-pit.

The patient's right hand is put in the "hip-firm" position. The operator, by means of his grip on the patient's uplifted arm, draws the trunk through a left-downwards-backwards curve to near the horizontal position. In the recovering movement, right-upwards-forwards, the operator gives resistance. Repetition for four to six times to each side, with a pause between, will be found enough, as the movement is very strong, and should only be applied to strong adults. Arch-twisting has powerful effects on the abdominal and pelvic organs.

(*c* 2) *Hips-firm ride-sitting screw-twisting* is a variation of (*a* 1) above, and requires two operators, who, standing behind the sitting patient, and with a single-hand grip on each shoulder, rapidly screw him alternately to right and left, on the pivot formed by their disengaged hands placed one above the other on the spine between the shoulder blades. The strength of the movement is determined by the position of the "pivot"—the lower the hands are placed on the back the stronger.

The movement is entirely passive, and is much used in catarrh and other diseases of the viscera and pelvic organs. In lung emphysema it is particularly beneficial, from the fact that the lower regions of the chest are alternately compressed; and for a similar reason the liver receives exhilaration, as does abdominal circulation generally.

The position of the patient is similar to that in *hips-firm high-ride-sitting alternate-twisting*, Fig. 15 (*q.v.*)

(iii.) *Arm-twisting* may be performed (one arm at a time) by the operator grasping the patient's right hand with his own right, or left with left, and twisting the arms to the fullest extent, so that rotation takes place in the shoulder-joint as well as between ulna and radius. The movement is a very efficient one in securing muscular development throughout the whole arm. It is usually done with resistance, though sometimes passively.

(1) *Yard-sitting arm-twisting with rod* is done by the operator grasping the ends of a short rod, which the patient, sitting on a stool, holds with one hand between the operator's two, and with the other grasping some steady vertical fixture. The twisting is done in this position against the operator's resistance, and is completed by him passively with vibratory action.

Note.—With this position and grip *arm-shaking* can also be well carried out.

(2) *Fore-arm-twisting* is best done by the patient's elbow being rested upon a table or other support, the operator clasping the hand, say with his right, and with his left steadying the arm with a grip above the elbow. This movement is intended to increase mobility between ulna and radius, and is usually performed passively.

As a stronger form the movement may be done with resistance.

(iv. 1) *Leg-twisting or rotation in the hip-joint.*—For position see Fig. 1.

The rotation may be performed passively or with resistance; and in both cases the whole leg must be fully extended, the foot being at right angles to the lower leg. Resistance is always applied through the foot.

The movement is a very potent one, as most of the leg muscles are brought into action.

(2) *Foot-twisting inwards* (for position *v.* Fig. 1) is a useful movement in "flat-foot" treatment.

The patient's leg is extended and the heel rested upon a support, and retained there by one hand of the operator.

The foot is rotated inwards by the patient as far as possible, the movement being completed passively with vibratory action by the operator, who applies strong pressure at the same time to the sole of the foot.

(3) *Foot-twisting outwards* (position as above) is a treatment for "club-foot." In this case the resistance on the part of the patient is of a very limited nature, the operator finishing the movement passively.

The important corrective effect is derived from the pressure applied to the sole of the foot by the operator.

In the case of children this treatment is often repeated in order to secure better results, as the joints are of a yielding nature.

Group III.

Hanging.—Hanging as a fundamental position has already been described; and as it stretches the spine it forms one of the most important movements in the treatment of spinal curvatures. In its various forms it acts as a muscle corrective, *i.e.* in producing a correct medium length, and so co-ordinating in power both sides of the trunk and arms; at the same time it is very beneficial in developing the arm muscles when it is combined with "heaving."

(i.) *Stretch-hanging heaving* is a position arising out of the F. H. P. (*q.v.*), and consists in the patient grasping a horizontal bar or two vertical posts, and lifting the body by means of the arms. Care must be taken that the head, shoulders, and elbows are drawn well back to obviate contraction of the chest.

(ii. 1) *Stretch-hanging neck-raising.*—The hanging is taken as before on a boom in F. H. P., and the operator places one hand with outspread fingers on the back of the patient's head, and the other on the front of the body. The head is moved forward passively, and when being raised by the patient the hand of the operator gives resistance. The raising should be done as far back as possible.

The object is to correct drooping-head and to strengthen the spine in its entire length.

(2) *Standing neck-raising* is a milder form of above, and is accompanied with resistance as before.

(iii.) *Side-suspension or hanging.*—The operator and patient stand on opposite sides of a boom. The patient stands on his toes, with his side to the boom, and bends sideways over it, so that the maximum convexity of the scoliotic curvature becomes the fulcrum of the movement. The patient does the bending over as far as he can, the operator continuing it by pressure. The strength of the operation and its duration may be gradually increased as the patient's endurance will allow.

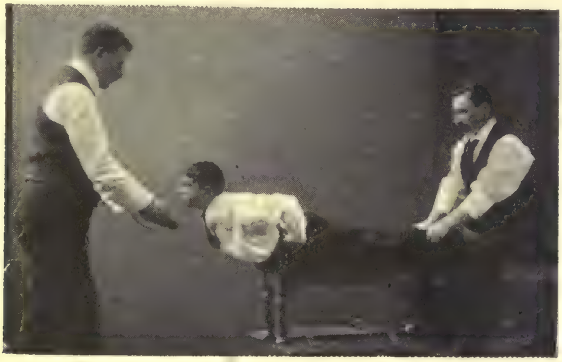

Fig. 17.—Hips-firm forward-lying-holding.

The maximum result is obtained when the patient is "suspended" over the boom, with his feet off the floor.

For further detail as to the direction in which pressure is best applied to scoliotic curvatures, see under Diseases, p. 213.

Group IV.

Holding.—Holding is practically a position in which the muscles are simply in active tension; although no actual movement is performed in holding, yet out of it many movements arise.

(i.) *Stretch-sitting-holding with rod.*—In this case the patient sits on a low stool and stretches his arms upwards to the full extreme, at the same time holding a rod near the ends, while the operator grasps the same at the ends with both his hands; and as he stands behind, his right will be contiguous to the patient's right, and left to left. In order to keep the patient's muscles in full active tension the operator resists slightly downwards during the stretching, so that there is a constant "push" upwards against this on the part of the patient. He will also take care that the "push" is equally distributed between the arms, and that the resistance, while steady, is not withdrawn until a few seconds after full extension has been attained.

The operator may also vary above by holding the rod in the middle with one hand, while he applies the other to any part of the back which is abnormal in curvature, or shows signs of "giving" during the movement.

The first part of this treatment is of great value in general weakness of the back, and in correcting rounded back or other faults of carriage.

(ii. 1) *Hips-firm forward-lying-holding.*—For forward-lying *v.* under derived positions and figure (Fig. 17).

Here the patient merely keeps his body in position over the end of the plinth, the operator standing in front to assist him back into a kneeling posture for resting purposes.

This will be found a very beneficial treatment both prophylactically for curvatures threatened in weak backs, and also curatively for curvatures that have already shown themselves. The body must never fall below the horizontal, and may with great benefit to chest and back be concavely curved upwards, as then all the extensor muscles of the back will be strongly contracted, and be more likely to retain a permanently proper medium length.

(2) *Neck-firm leg-forward-lying-holding* and

(3) *Stretch leg-forward-lying-holding* are two other forms of graduated strength; the latter, being very strong, should never be given to weak patients.

(4) *Stretch leg-forward-lying neck-raising* is performed in the above position, except that the patient stretches both hands upwards and rests them upon the operator's shoulders, who, laying one hand on the back of the bent head, gives resistance to the raising of the head.

Group V.

Rolling.—This is a movement much used in medical gymnastics, and is applied to all joints capable of being rolled. When a joint suffers from diminished mobility it may be successfully treated by rolling; and even when in a normal state, the movement will be preservative and will also further circulation, which last is, when applied throughout the body, of the greatest importance.

Trunk rollings, on this account, are extensively used in diseases of the circulatory and digestive organs, and will be frequently referred to below.

(i.) *Toe and finger-rolling* can be performed similarly; and along with flexion and extension (*q.v.*) are of benefit in circulatory ailments and diminished joint mobility.

Toe-rolling is specifically applied in spasmodic contractions due to nervous diseases.

Finger-rolling is applied in the third phalangeal joint thus:—The operator grasping one hand of the patient with one of his own just below the wrist-joint, with his other manipulates the thumb, and afterwards the four fingers *en bloc*, by making the points of the fully distended fingers describe a circular curve, whose limit is determined by the structure of the joints. When the joint in any one finger requires to be specially treated that finger should be separately rolled. The movement is always passive.

(ii.) *Foot-rolling* can be given actively or passively, the latter being preferred. When the movement is active the patient should sit so high that his feet do not touch the floor; and the passive will be performed best in

Half-lying position (*v.* Fig. 1). The hands of the operator must be one above the ankle-joint, and the other palm to sole; fingers and thumb clasping the toes. The grips must be firm. The rolling must not force the foot into extreme dorsal flexion, as rotation through that point is impossible owing to the structure of the ankle-joint.

Foot-rolling can be performed double by two operators acting at the same time.

(iii.) *Leg-rolling* is a hip-joint movement and is always performed passively; it is usually carried out as in Fig. 18, but often, as when the patient is confined to bed, in a lying position.

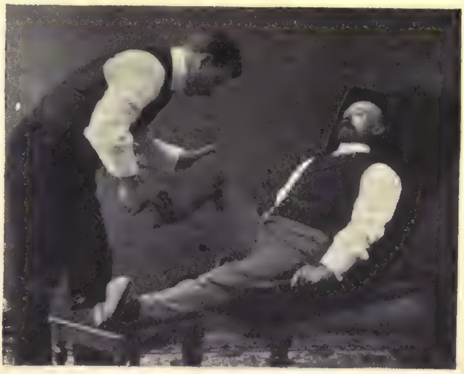

Fig. 18.—Half-lying leg-rolling.

The position in leg-rolling is the same as in *knee-updrawing and down pressing*, which usually follows a leg-rolling.

Half-lying leg-rolling.—The operator stands at right or left front of the patient, grasping the arch of the foot with one hand thumb inwards, and with the other, the knee, the fingers pointing upwards. Both of the patient's legs are put on a stool before the movement begins. The operator bends one leg of the patient at the knee as shown in the figure, and rotates the knee in as wide a sweep as possible, the foot being kept as closely as can be in the sagittal plane. Care must be taken to make the movement one for the hip-joint and not for knee or ankle, and that the patient be entirely passive.

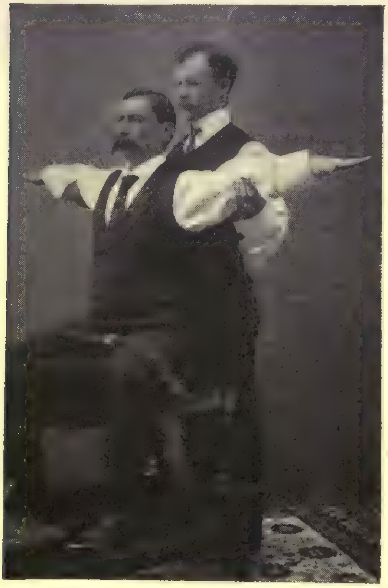

FIG. 19.—Yard ride-sitting double-arm-rolling.

This movement is called "the big blood pump," from its action in exhilarating the circulation. The pelvic and abdominal organs are also beneficially affected by it; and it is always used in cases of diminished mobility of the hip-joint.

(iv.) *Hand-rolling* is best done by the operator sitting or standing by the side of the patient, placing one hand above and the other below the wrist, both being on the dorsal side. The direction of the rotation may be changed after twenty rollings the one way. The movement is usually passive, but may also be performed actively.

(iv. 1) *Yard ride-sitting double-arm-rolling.*—The operator stands behind and grasps the upper arms of the patient, as shown in Fig. 19, and giving support to the patient's back with his chest. The arms are carried in large circle forwards, upwards, backwards, downwards, at the rate of about forty rollings per minute, and continued for two or three minutes.

For patients with weak hearts the arms must never be moved higher than the horizontal plane. The movement here is passive; but for strong patients it can be done as an active movement in free-standing exercises.

(iv. 2) *Sitting single-arm-rolling.*—This is a modification of above movement, and is intended for weak-heart cases (Fig. 20). The operator takes the grip, as shown in the figure, and so performs the rolling.

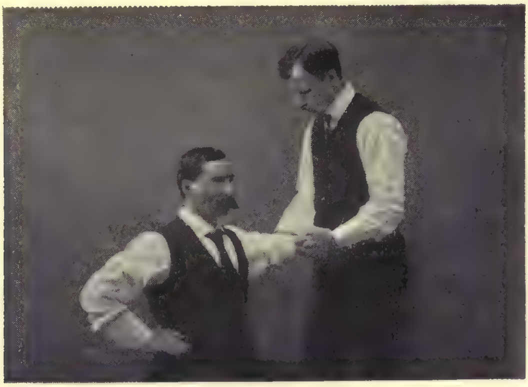

FIG. 20.—Sitting single-arm-rolling.

When stiff shoulder is to be treated the single-arm movement is best; and then the arms must be fully extended while the patient takes a yard-sitting position. The rollings will begin with the largest circle permitted by the stiffness; and after this has been repeated with the arm pointing in various directions, the circles should be gradually increased until the fullest range of sweep permissible in the joint is attained.

(iv. 3) *Half-lying double-arm-rolling* with flexion and extension (*v.* Fig. 4) is another form of rolling, stronger than above, and not intended for weak-heart cases for the reason stated in (iv. 1) above.

(v.) *Head-rolling* can be done in different positions, *e.g.* in (1) arm-lean-standing, (2) arm-lean-sitting, and (3) sitting, which are given to improve circulation and mobility in the atlanto-occipital joint, counteract muscular stiffness and rheumatism in the neck.

The operator stands by the side of the patient, placing one hand on the forehead and the other on the occiput, fingers outspread, and from this position performs slow extended rolling eight to ten times each way, and giving a slight pause for rest. This may be repeated several times, depending on the object of the treatment. The grasp should be firm without undue pressure, steadiness and unity of the movement being of great value.

The important effect of head-rolling is the acceleration of the circulation in the head and the promotion of the blood-flow through the jugular veins. Care should be taken in heart cases to graduate the range of the rollings, as giddiness, faintness, and discomfort may ensue. The best position for treatment for stiffness in the neck is shown in Fig. 14.

(vi.) *The trunk-rollings*, the last group of rollings, is of great importance, and can be performed both actively and passively.

As an active movement the best position taken up is

(1) *Hips-firm stride-standing trunk-rolling.*—The F. S. P. should be well taken: then a stride made, each foot being carried sidewards one foot's length, the weight of the body being equally distributed on both feet. The trunk is bent forward throughout its whole length through about 30° from the vertical. The trunk is now moved in a circle to the right, backwards, left and front again. This is repeated eight to ten times; a pause is made; the rolling is begun again in the contrary direction, *i.e.* to left backwards, right and front again, for eight or ten times. This can be again entirely repeated as prescribed, usually from three to five minutes at a time.

(2) The passive movement is termed

Hips-firm high-ride-sitting trunk-rolling.—The direction of the rolling is as in (1) above: the operator standing behind the patient places his right hand on the right shoulder, and his left in the patient's left arm-pit; from which position he performs the rolling, beginning by flexion towards the right, then backwards, left, forwards, and so on. The position of the hands is reversed for the contrary direction.

The patient must take care to keep the trunk in a straight line by his own muscular strength.

In heart cases, and in weak and stout ones, the operator must be careful that the bending backward does not overstretch the abdominal muscles and so impede the respiration.

Group VI.

A. Hacking is a form of stroke (or beating) applied to the nerve-lines when they lie near the surface. The weight of the "stroke" is varied according to the necessity of the case, by being applied (1) by the finger-tips (tapping); (2) by the ulnar side of the little finger; (3) by the dorsal surface of the three middle fingers.

The operator should perform all hackings as far as possible from the wrist, and not with the whole arm; and so lightly and elastically, that the fingers have a very short contact with the part treated, except in cases of muscle hacking, when the operator adds strength to his stroke on contact with the part *e.g.* in (3).

Hacking is a difficult movement to perform, and only the skilled operator can carry it out well.

It can be performed with one hand or with both used alternately.

(i.) *Head-hacking* is performed by the operator standing in front while the patient sits (Fig. 21). The strokes are administered by the finger-tips of alternate hands, the little finger striking first, and being followed in rapid succession by the other fingers, so that there is actually a group of four small blows applied at one time.

The little finger should fall on the middle line of the head, and be followed by each finger in turn, while a slight stroking with the fingers on the side parts of the head is included in the "hacking."

The treatment should begin at the eyebrows and travel up the forehead, over the head, and down the neck.

About twenty to twenty-five strokes are given in passing over the whole range of operation; and this should be repeated during five to ten minutes, according to the effect desired.

In cases where chronic ennui or lack of energy has to be remedied, the stimulative form of head hacking, *i.e.* with the finger-tips, ought to be employed, the "strokes" falling quicker and with greater strength.

Insomnia, headache, neuralgia, and hysteric ailments, as well as brain fatigue etc. should be treated with the "soothing stroke," *i.e.* with the palmar surface of the fingers. The hacking impacts must be softer than before, and less rapid; they should gradually diminish in both qualities, until they merge into a "smoothing" of the head with the full open hand, and cover the whole surface of the head (temples and forehead included) and neck, and be continued down on to the thorax or arms.

This is a very safe operation in all nervous cases, and when accompanied by other forms of medical gymnastic treatment, acts beneficially in the great majority of instances, and can never do harm if the manipulation be properly carried out.

(ii.) *Back-hacking* is used as a nerve stimulant, and is applied with the number (2) stroke explained above, and as shown in Fig. 22. The patient may sit or stand, or in delicate cases lying prone in bed. The operator always acts from behind.

The whole back from the cervical to the sacral regions may be treated, the strokes falling from each hand on alternate sides of the spine. In going over the whole back about fifty strokes may be given with each hand, and the whole may be repeated as thought necessary. This is called *length-back-hacking.*

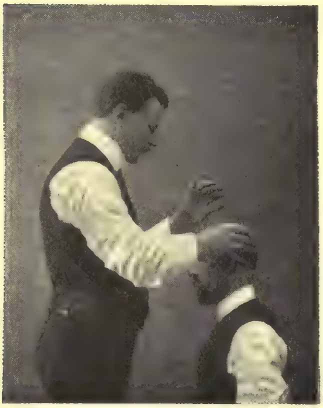

FIG. 21.—Head-hacking.

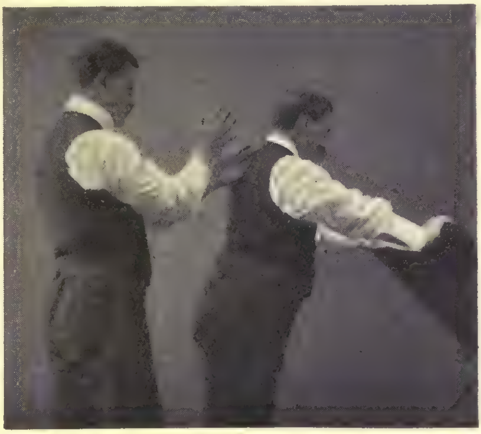

FIG. 22.—Back-hacking.

The hacking may also be administered by commencing on the spine and proceeding to right and left towards the sides, and taking each vertebra roughly as the starting-points in descending order, and is then called *diverging-back-hacking.*

Note.—Back-hackings are very beneficial as medical gymnastic treatment for fatigue and back-aches, as well as for chlorosis, inflammation, and muscular weakness. Under a skilled operator heart diseases and affections of the lungs can, in certain circumstances, be much alleviated by the above process.

(iii.) *Side-hacking* indicates that the chest may be treated similarly to the back; the patient may sit or stand, the former attitude being the better.

(iv.) *Heart-hacking* must only be carried out with the warning given in number (ii.) above, and in more detail the results of this manipulation will be given under Treatment of Heart Disease (Fig. 23).

The patient's position should be as easy and comfortable as the affection and operation will allow. Half lying is the best, as shown in Fig. 23.

The operator sits on either the left or right side of the patient, and administers the stroke as described in Group VI. (2) above, and using his two hands alternately, taking care that the hacking is done very gently.

Heart-hacking is often varied to a light elastic clapping with one hand, finished off with a gentle "tremble-shake" or stroking. (See under Vibration, Shaking, Stroking.) The whole operation usually lasts only four or five minutes.

(v.) *Muscle-hacking* given in the form described under Group VI. (3) above, and is applied to arms and legs.

Muscle-hacking can also be given on other parts of the body, and the methods (2) and (3) above are the best "strokes" for the purpose.

B. CLAPPING is of two kinds—(*a*) light, and (*b*) heavy; the former has a short light contact, and is administered more rapidly than (*b*), which is heavier and meant to influence parts below the surface; more weight is given to the "stroke," or the contact is accompanied by pressure. In both cases the whole palm touches the part affected, which gives no pain to the patient; the stroke with the finger-tips should therefore be avoided.

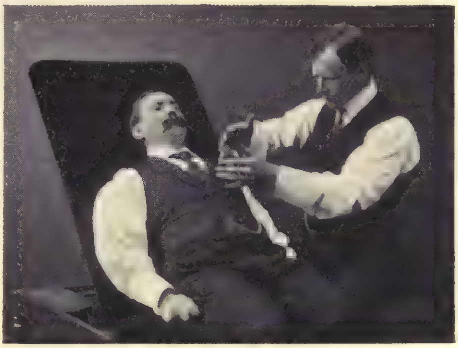

FIG. 23.—Heart-hacking.

(i.) *Chest-clapping* is applied to the whole chest (back, sides, and front), beginning on the spine between the shoulders, the "strokes" spreading slowly outwards, then downwards to the bottom of the chest parallel to the spine, then down the sides, and then down both breasts, the whole being repeated three or four times.

As the operator stands in front of the patient, who is grasping two uprights, the administering of the operation to the back parts by reaching under the patient's arms presents some difficulty and requires practice.

The strokes should be given alternately to the back and front, but are best given "simultaneously" on the sides, less force being used in the "claps" when over sensitive parts of the front of the chest, and stronger on the back.

There are different positions in which the above operation can be performed, but the method of clapping does not vary, unless it be desired to operate on one particular area only.

If in this operation it is desired to influence the respiratory process and make it deeper, the patient may assist the effect by *arm-heaving upwards-outwards* simultaneously with the passive application.

Chest-clapping is usually prescribed in cases of bronchitis, shortness of breath from various causes, and emphysema of the lung. The shocks administered to the chest during the above treatment bring about the discharge of the mucus which blocks the bronchial tubes and interstices of the lungs.

Convalescent patients, who are weak generally, nervous cases, and others in need of bracing up, can be beneficially affected by above process, when of course accompanied by other forms of medical gymnastic treatment.

In *paralytic* cases "clapping" applied to the extremities should be of such weight and rapidity, that the part is "shocked" into sensibility, and where the sensibility of the muscles generally is weak the same treatment is advantageous. Of course the proximity or remoteness of bones to the surface of the part operated upon will aid the practitioner in regulating the weight of his strokes. Clapping on the extremities is preceded usually by a process of muscle-kneading (*q.v.* below).

C. BEATING, along with the two immediately preceding movements, forms a group graduated in strength, hacking being lightest, clapping stronger, and beating strongest.

Beating is an application to stimulate muscles.

The stroke should be administered with the fingers closing upon the palm, but care must be taken to avoid making this a "blow" with the "fist." This movement is made like the others of the group from the wrist and not with the arm, as then the effect would be to cause pain.

The operator must exercise discretion as to which persons and parts of the body can be treated by this process.

It is usually applied for rheumatism in the hip-muscles under the name hip-muscle-beating.

(i.) *Hip-muscle-beating* is done while the patient is in a forward-lying or an arm-lean-standing position.

The beating may be applied downwards all over the thigh, and when sciatica is present the stroke may (when the disease is not acute) be varied to have a penetrating effect.

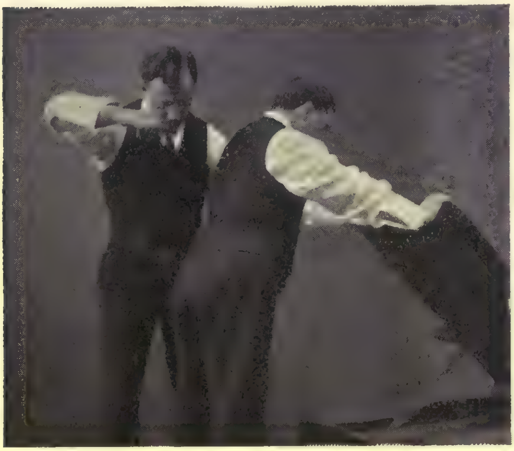

FIG. 24.—Hip-muscle-beating.

(ii.) In *sacral-beating* the position is taken as shown in Fig. 24, the patient turning his feet slightly inwards; other variations in regard to support, however, may be adopted. The strokes when well administered should produce an agreeable sensation, but in order to attain this the points of impact should form a curve beginning from the one trochanter to the other across the buttocks, dipping slightly from the straight line at the middle point. The whole sacral area can be covered by a series of these "curve lines of impact." The operator gives his stroke with one hand, the other supporting the abdomen of the patient, which support is of great importance when the abdominal parietes is relaxed. The value of this manipulation with reference to pelvic and abdominal organs will be referred to under Diseases. It is sufficient to state here that sacral beating has been proved to be very beneficial in treating atony of the rectum and bladder and constipation.

Group VII.

A. KNEADING is only applied to muscular parts, and the area operated upon must be so placed and supported from beneath that complete passivity is attained, otherwise the treatment partly loses its efficacy and is more difficult to perform. Muscle-kneading can be administered either with the whole hand or with the fingers, depending upon the parts to be treated. Among kneadings the usual forms are muscle and abdominal kneading.

(i.) *Arm-muscle-kneading* as shown in Fig. 25.

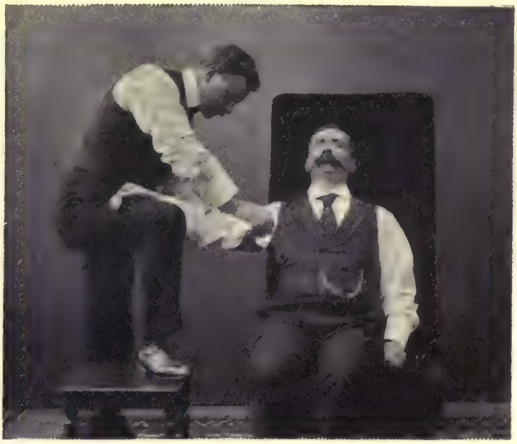

FIG. 25.—Arm-muscle-kneading.

The operator gives support to the patient's arm, and grasps the same with both his hands near the shoulder, and while squeezing the muscles above and below the arm alternately, he moves the hand with a rotatory motion up and down alternately. He will thus cover the whole surface of the arm from shoulder to wrist, keeping the whole hand in contact with the arm, and at no time during the process lifting either hand.

It has been supposed that the direction of this movement should be from wrist to shoulder as in massage; direction, however, has no special value, and since from "shoulder to wrist" is easier and more efficient, this order ought to be adopted. The above treatment of muscle-kneading is usually given in cases of muscle rheumatism, muscle inflammation, paralysed and enervated or over-exerted muscles; and it has been practically demonstrated that after a course of kneading muscles are better able to do the work required of them.

In cases of elderly people, delicate or bedridden patients, when the functional activities are weak, the action of the muscle groups, which is deficient, and upon which these activities depend, can be replaced by muscle-kneadings. All the ailments which follow the want of exercise may to a great extent be alleviated by muscle-kneading. It is almost a rule without exception that this manipulation, by keeping up the tone of the whole body, assists the progress of patients towards recovery when under medical or surgical treatment.

Muscle-kneading has been found of great value in heart disease cases, as it exhilarates circulation, and thereby assists the heart's action and lightens its strain; this physiological fact is explained in Introduction and under Diseases of the Circulatory Organs.

This manipulation must not be confounded, as to its effect, with petrissage, which will be fully explained under massage.

Muscle-kneading is performed on the legs as well as the arms, and in this case is best done as—

(ii). *Half-lying leg-muscle-kneading.*—The operator raises the leg to be manipulated upon his knee in order to conduce to complete passivity, and admit of the leg being in the most convenient position. In certain cases when the posterior muscles of the thigh require to be operated upon specially, the position may be changed to forward-lying on a couch or other support.

The method of manipulation is similar to that in (i.) above.

(iii). In *neck and shoulder muscle-kneading* the operator stands or sits by the side or behind the patient. Method as before.

It is sometimes necessary to grip the muscle between the thumb and the other fingers and then perform the manipulation.

(iv.) *Abdominal-kneading* includes three important groups of movements, called —(*a*) kneading, (*b*) shaking, (*c*) stroking.

Only those manipulations which are directly applied to the alimentary canal (stomach, duodenum, the colon, or other part of the bowel) are referred to here.

(*a*) *Abdominal kneading* is performed on the patient (Fig. 26) while in the *hook-half-lying* position shown in the figure. The abdominal muscles are hereby relaxed.

The operator sits on the right of the patient, placing the palm of the right hand on the centre of the abdomen. From this point the hand is moved spirally until the whole area of the abdomen has been covered; and during the whole movement pressure is given down upon the intestines in order to move them from side to side.

While the hand is moving spirally the point of "strongest contact" between hand and abdomen travels round the "rim" of the hand, *i.e.* first, pressure at the wrist, next on the thumb, then on the finger-tips, lastly, on the ulnar side of the hand and back to wrist again. When the wall of the abdomen has been reached the direction of the manipulation is circular, following the wall, and the operation is continued or repeated as long as is considered necessary. There is also a double handed pressure, when movement of a stronger nature is required; and this is made by placing the left hand upon the back of the right, and carrying through the manipulation as above.

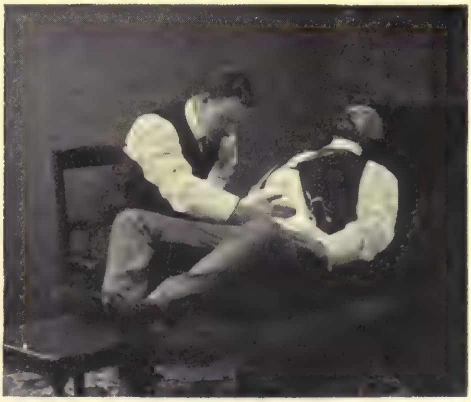

FIG. 26.—Abdominal kneading.

A third method, equal in strength to the first, but covering a greater area at one time, is carried out by the operator standing in front of the patient, placing his right hand on the right and his left on the left of the abdomen. Both hands are moved in a circular direction simultaneously, the "point of strongest contact" and other details being regarded, as before, as far as possible. The circles performed by each hand may overlap on the middle line.

The strong movements above are generally employed in cases where the muscles and fat would interfere with the "single-hand" manipulation.

(*b*) *Abdominal shaking* is divided into—

(*b* 1) Stomach shaking; (*b* 2) Stomach-pit-shaking; (*b* 3) Abdominal-side shaking; (*b* 4) General abdominal-shaking.

All done in the half-lying position.

(*b* 1) *Stomach shaking* (Fig. 27).

The operator stands on the patient's left side and facing his feet. Both hands with opened fingers are placed on the abdomen above the major curvature of the stomach. The finger-points are "fanned out" and pressed down; the vibration or shaking is now begun, the pressure being continued in an up direction and towards the middle line.

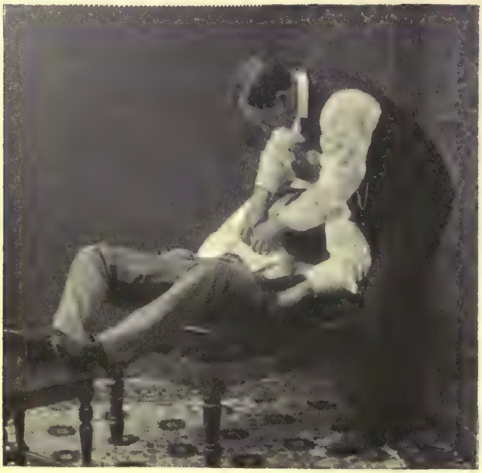

FIG. 27.—Stomach-shaking.

This movement is one of the most important in treatment of dilatation of the stomach and is also employed to mitigate pain in the epigastrium and to improve appetite. Five to ten minutes stomach-shaking will be enough, and also of stomach-pit-shaking in (*b* 2) below.

(*b* 2) *Stomach-pit-shaking.*

The operator stands, as shown in Fig. 28, with both hands turned towards each other, and the finger-tips resting on the middle line between the end of the sternum and the navel. He should endeavour to arrange his fingers so that the tips lie in the same place and touching one another; the long fingers will therefore be more crooked than the short ones. When this position is attained a slight down pressure is given and vibration or shaking is begun. The fingers pressing upon the wall of the abdomen push the same in front of them and move towards and under the wall of the chest, a steady and rapid vibration being continued all the while.

When the hands have gone as far as is considered necessary, they are returned to the starting-point and the operation is repeated.

(*b* 3) *Abdominal-side-shaking.*

The patient takes a half-lying position. The operator standing in front and leaning over the patient, places his open palms with fingers extended on the waist of the patient, the thumbs almost meeting in front. Pressure is exerted against the sides, *i.e.* making a strong clasp. The hands are now quickly moved in contrary motion, so that while the patient's right side is drawn towards the navel, the left is pushed round towards the spine and *vice versa.* This quick shaking causes the wall of the abdomen to be rapidly moved from side to side, and is much used in cases of catarrh of the large intestine.

(*b* 4) *General abdominal-shaking.*

A general shaking of the abdomen can be given by the operator standing by the side of the patient, whose position is as before, and placing his hand on the epigastrium, and shaking from side to side, gradually carrying his strokes downwards till the whole abdominal area has been treated. The wall of the abdomen is thus pushed and drawn by the hand from side to side.

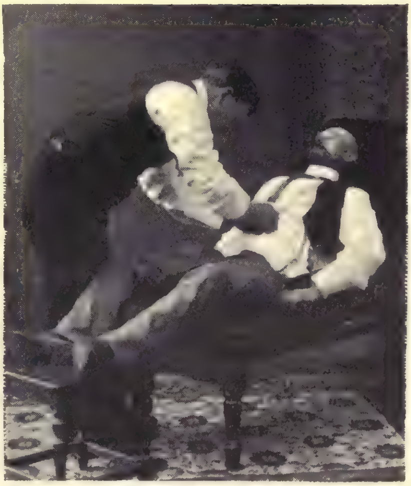

FIG. 28.—Stomach-pit-shaking.

A second method requires two operators, who sit on opposite sides of the patient, one hand of each being placed on the abdomen, one above the other.

The shaking resembles that described above, but the hands retain the one position throughout. The shaking is more rapid in this operation than in the previous one.

Diarrhœa can be beneficially treated by this movement, which is sometimes called *transverse-abdominal-shaking.*

(*c*) *Abdominal stroking* is an operation which exhilarates the peristaltic action of the intestines, and along with other manipulations and movements for the abdomen, gives this process the fullest activity.

Strokings are divided into several forms, the most important of which are (*c* 1) colon-stroking, and (*c* 2) sphincter-stroking, better termed anal-massage.

(*c* 1) *Colon-stroking* is a movement usually performed after a process of abdominal-kneading; it is a powerful operation for constipation.

The patient is in a crook half-lying position, as in Fig. 28. The operator, standing in front, lays his right palm (fingers lying towards the right side of the patient) on the fossa iliaca. A strong pressure is exerted with the wrist, while the hand is moved up the vertical colon. The operator then changes his footing and directs his hand, fingers first, and strokes along the transverse colon; and again stepping back to his original position, strokes the descending colon, wrist first, but pressing now with the finger-tips, assisting the movement of the fæces into the anal passage.

A second method, which has the further advantage of disintegrating the fæces, is performed by the operator standing at the patient's right side, but facing his feet. Several rapid strokings with strong finger-tip pressure are made up the ascending colon; a similar number along the transverse (pressure being applied by the wrist as in first method) finishing by strokings down the descending colon as before.

The first may advantageously follow the second.

Some authorities in medical gymnastics disregard "the direction of the strokings," looking merely to the reflex benefits; but, as in the above treatments, the operation is a strong one, the peristaltic action is much exhilarated mechanically, and the reflex benefits not lessened.

(*c* 2) *Sphincter-stroking*, better termed *anal massage*, since it includes not only stroking, but also shaking and pressing; and, further, it here means treatment for the rectum.

This manipulation is employed for a number of ailments, chief of which are hæmorrhoids, prolapsus of the rectum, atony of the intestines, etc.

An injector of some sort is used,—wood, vulcanite, horn, etc., the finger or the special appliance fitted to a mechanical vibrator intended for this purpose. For internal anal-massage the injector of the vibrator, which is about the thickness of the little finger, and fitted with a disk to check it against the anal aperture, is coated with vaseline and gently inserted; vibration is then administered.

External treatment to the anus may be administered by means of a rod or the finger. The rounded end of this appliance is placed against the anus, firm pressure is exerted, and circular strokings are administered to the aperture with the head of the rod.

This stroking may be alternated with shaking; and the sphincter muscle will contract and prevent the injector from entering the rectum. The part need not be nude during external treatment, which may be done effectively through the shirt.

B. PRESSING is to a large extent merely a corrective aid to the better performance of some particular movement; at the same time there are pressings *per se*, and to these attention will be here directed. The most important form is *nerve-pressing.*

Nerve-pressing may be administered generally or locally. In the former case no nerve is particularised, but a stimulating effect is produced on the system. In the latter case some nerve is singled out, and the finger-tips of the operator's hand laid along it for the purpose of pressure or pressure with vibration.

Both forms may be administered to the extremities in cases of paralysis and other nervous disorders.

(i.) *Local nerve-pressing.*—After the nerve has been located it may be operated upon by the fingers "twanging it" as one does a violin string. This may be repeated several times. A second method consists in pressing the nerve continuously for minutes or even hours. The application of these methods will be referred to in the record of cases. It may, however, be mentioned here that sustained pressure has produced good results in muscular tremors, St. Vitus' dance, etc.; while the "twanging" process has brought about reaction when electric treatment has failed to do so.

(ii.) *Back nerve-pressing* is usually performed for fatigue, exhaustion, scoliosis, muscle-ache, and inflammation, paralysis, chlorosis, etc.

The patient should assume the standing position as in Fig. 29, or a lean-sitting or a forward-lying position.

The operator from behind places a hand on either side of the patient's spine, presses the three middle finger-tips of each hand firmly into the back, keeping them in a position transverse to the spine; vibration sidewards is administered at the same time. The process is repeated by descending in steps of about one vertebra at a time, until the whole back has been treated; this may be repeated several times as required.

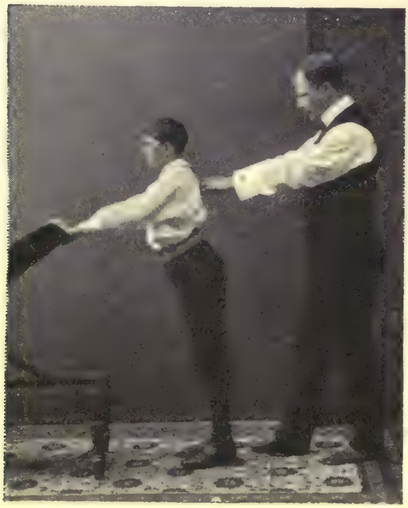

FIG. 29.—Back-nerve-pressing.

Another excellent method, particularly adapted to patients in bed, is also employed. The operator places the thumb of his hand on one side of the spine, while the three middle fingers of the hand touch the other side; firm pressure and vibration are simultaneously applied, descending as before. In this case the finger-tips will lie in a line parallel to the spine, though the direction of the vibration is transverse.

(iii.) *Pressing above the pubis* used in cases of urinary diseases, prolapsus of the rectum, and uterine complaints. The treatment is not intended directly to affect any special organ, but rather indirectly through the pelvic nerves.

(iv.) *Bladder treatment with pressing and vibration.*—The operator should, as a rule, precede this treatment with abdominal kneading to secure the emptying of the intestines, as the presence of hard fæces frequently gives rise to pain and impedes the treatment. Regularity of the bowels' action is a necessary condition to the best results.

The patient should be quite passive in a lean-forward-sitting position, except in cases of considerable obesity, when the half-lying position brings the organ more near to direct manipulation.

The treatment is begun by the operator giving massage à friction (*q.v.*) above the region of the bladder, using the whole palm in so doing.

The accessibility of the bladder to massage depends upon the position taken. The operator sits on a stool somewhat lower than and facing his patient. He places his palms, open towards each other, fingers first, on the abdomen, one or two inches above the pubis, or more in the case of a stout person; he pushes his fingers down upon the bladder, at the same time putting aside the parts of the intestines which lie in his way. He then vibrates while he presses the bladder down into the pelvis and forward towards the symphysis.

This movement should be repeated during five or ten minutes, and the pressure should be so strong as to cause a desire, on the part of the patient, to make water and empty the bowels; this is a proof of the efficacy of the treatment.

In obese patients it may be necessary to manipulate the bladder through the rectum or perineum, as the fat abdominal wall impedes the anterior operation.

It should be borne in mind that the abdominal muscles will feel a sense of soreness for several days at the beginning of the treatment, but it should not be abandoned on that account.

C. SAWING.—Sawing is a movement applied by the hand being moved across the muscle to be treated in a manner suggested by the name, the ulnar side of the hand being in contact with the part. When firm pressure accompanies the movement the effect upon the underlying muscles will be deep, and when less pressure is exerted the action affects the skin and the subcutaneous tissues.

Neck-muscle-sawing is the most common form of application of the movement, and is generally prescribed in rheumatism and muscular contraction. It is given as a substitute for muscle-kneading, when its application is more convenient and more efficient than that process.

Muscle-sawing may be applied to the arms, legs, and back.

Group VIII.

Vibration or Shaking.—Vibration or shaking is one of the most important and generally efficacious methods employed in medical gymnastics for the treatment of nervous disorders.

It has been frequently referred to above, although not explained; but its name would suggest the limited purpose to which it has already been put.

Shaking may be administered by hand or by machine, each method having its own special value. Shaking may be employed to diminish or increase the heart's activity. Further, in cases of catarrh the mucus can be detached from the mucous membrane by this treatment.

There are two groups of shaking movements, differentiated as they are, of local or general application.

(*a*) In the first case the part itself is actually shaken, as already described in abdominal movements.

(*b*) In the second case the shaking is administered upon and not to the part; and of course is of a weaker nature than the former. The latter obviously leaves the part affected in a generally passive condition.

(i.) *Larynx and pharynx shaking.*—The patient takes a sitting position, while the operator with one hand steadies the head, and with the other grips the part to be treated thus: the thumb and forefinger are placed on opposite sides of the larynx, and shaking from side to side is administered, followed by stroking down the throat (Fig. 30).

This manipulation has a beneficial influence in cases of chronic catarrh, and where the laryngeal muscles have lost tone through anæmia and prolonged fevers.

The practice of internal manipulation of the larynx may be carried out by using the finger or an instrument, but as this is a specialised form of treatment it should not be taken up by the general operator.

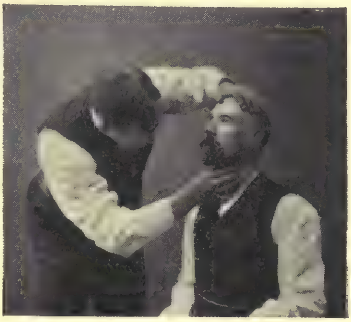
Fig. 30.—Larynx and pharynx shaking.

(ii.) *Nose-bridge-shaking.*—The position of the patient is as in (i.) above. The operator, standing at the patient's right front, steadies the head with his left hand on the crown, and grips the bridge of the nose with thumb opposed to the three middle fingers. The vibration may be given from side to side with the head in one position.

In a second method the operator places his hand on the occiput of the patient, who keeps his neck muscles quite passive, allowing the head to fall forward on the chest. From this position the vibration begins, and is continued while the patient's head is raised through an arc of a circle by the pressure on the nose, till the head fall full back on the spine. The head is again drooped and the treatment repeated. This movement is used for chronic catarrh in the nose and for chronic bleeding, in which case the treatment is very gentle.

(iii.) *Aural vibration*, a treatment given to alleviate deafness, noises in the head, and earache.

This can be done by means of a vibrating machine or by the hand; the latter method in a skilful operator's hand has been proven of great value (Fig. 31).

The vibration is applied in circles right round the ear, the circles being decreased in radius until the ear itself is reached, when the manipulation is applied to the aperture.

(iv.) *Chest-shaking* is a movement intended to deepen inspiration, and besides benefiting the respiratory process directly and indirectly, it is also of the greatest importance in diseases of the lungs and heart.

Chest-shaking furthers expectoration from the lungs. The patient's position may be standing or half-lying.

(v.) *Heave-grasp-standing chest-tremble-shaking.*

1. The patient stands facing the operator and gripping two uprights.

The operator lays both hands on the upper region of the chest, one hand on either breast. The hands stroke the chest downwards, at the same time "trembling."

2. In a second method the hands of the operator are placed on the back by the arms being passed under the arm-pits.

Trembling is administered, while stroking outwards from the spine, downwards and forwards under the arm-pits, is applied. This process aids expansion of the chest more than the former.

(vi.) *Side-tremble-pressing* (*shaking*).—The patient stands as in (v. 1) above.

The movement commences on the side walls of the chest by the operator pressing his hands there just after the patient has inspired deeply. The hands are trembled downwards and pressed against the sides during the exhalation, and the rate timed so that the hands reach the lower chest at the end of the breathing out.

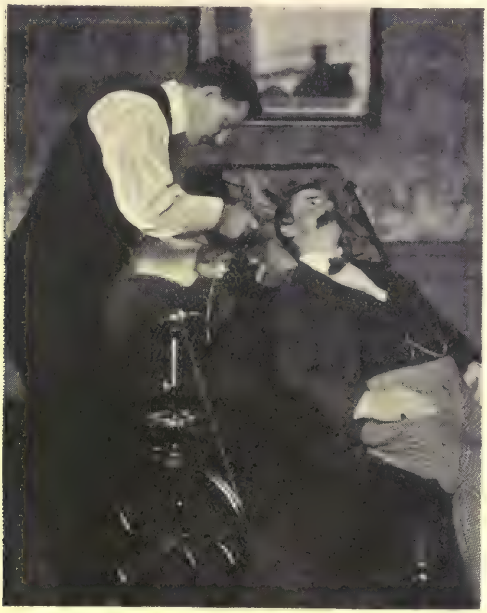

Fig. 31.—Aural vibration.

The pressure at this point helps to fully clear out the residual air.

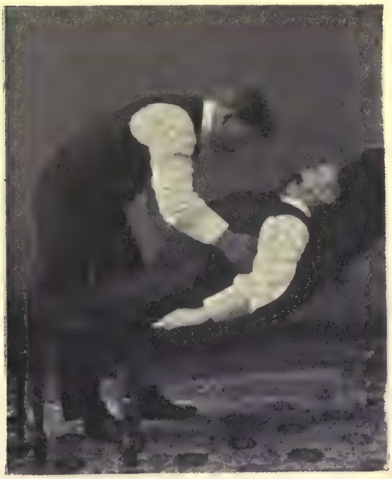

Fig. 32.—Half-lying chest-lift-shaking.

This movement reduces over-activity of the heart, and is very beneficial in emphysema cases.

Similar effects are produced by movements (vii.) and (viii.) below.

(vii.) *Heave-grasp-standing back-tremble-shaking.*

(viii.) *Arm-lean-standing back-tremble-shaking.*

In these the operator, standing behind the patient, places one or both hands on the back between the shoulders, and during expiration only performs the shaking.

When both hands are used one may be superposed on the other.

(ix.) *Half-lying chest-lift-shaking.*—This movement is very suitable for patients lying in bed (Fig. 32). The operator, standing at the side, reaches over and places one hand on either side of the back, and while raising the patient tremble-shaking is applied. The hands travel downwards towards the lower part of the chest, and finish up by being brought round towards the front; the patient by his own weight resumes the initial position, and the operation is repeated. The patient should observe complete passivity.

(x.) *Arm or leg shaking* is performed by the operator taking hold of the hand or the foot, extending the limb, and shaking it quickly. Nervous disorders and aches may be beneficially influenced by this movement.

(xi.) *Under-kidney tremble-shaking.*—This movement is used for "floating kidney." (*a*) The patient is put in hook-half-lying position. (*b*) The kidney is put back into place by the operator. (*c*) The operator now applies the manipulation, giving a deep and continuous tremble-shaking, at the same time pressing upwards in the direction of the replaced kidney.

(xii.) *Half-lying heart-tremble-shaking*, already referred to under Group VI. above (Heart-hacking).

Group IX.

A. Stroking and Friction, already referred to as a treatment for constipation (in colon stroking), produces—(1) a mechanical effect; (2) Reflex action, as in transverse abdominal stroking, also referred to already; (3) Soothing. These stand in descending order of strength and penetrative result.

(3) is used after strong manipulations to take away feelings of pain or inconvenience which may have been occasioned to the patient. The sedative result nervously makes this a good finishing movement.

(i. 1) *Leg and arm stroking* is a rapid movement performed with the finger-tips, from wrist to shoulder or ankle to hip, with both hands. While the movement acts superficially and exhilarates the vessels of the skin, it is also of considerable firmness.

(2) In a second method the direction of the stroking may be reversed when following strong muscle-kneading, clapping, or beating, and has a soothing effect.

(ii.) *Arm-lean-standing or sitting-back-stroking.*—This is performed with the whole palmar surface of the hands, alternately passing down the whole length of the back on each side of the spine; it is usually done after hacking or clapping or back-nerve-pressing.

(iii.) *Sitting-head-stroking.*—The open palms are applied to the forehead, passed over the head (covering as much of it as possible), down the sides of the throat or face, and continued down shoulders and arms or chest alternately. The movement varies in rate and strength, decreasing from the first stroking to the last, when the patient is barely touched. The variations must be left to the judgment of the operator, according as he is treating for insomnia, hysteria, megrim, or other nervous disorders.

The process is fundamentally a sedative one; should always begin at the forehead, and when insomnia in particular is to be influenced; the stroking should go far down trunk or arms, and decrease, as stated above, in speed and pressure.

The above process of stroking must not be confounded with massage-effleurage, since it is not an operation upon the venous vessels (and therefore going to the heart), but rather upon the peripheral nerves, and applied in any direction.

B. Friction.—Friction is a movement so much applied to nerve-lines that it will be referred to below as meaning "nerve-friction." Although the movement has a resemblance to stroking, its purposes and effects are generally different, and its direction as a rule is centrifugal. The movement is performed by bringing either the palmar or dorsal surface of the finger-tips into contact with the part, or by acting on a nerve-line with the tips of the closed thumb and forefinger. The speed of the movement is varied according to requirement, and the lines traced by the finger-tips may either be straight or be combined with minute lateral vibrations.

Friction to the scalp is best carried out by applying the dorsal surface of the finger-nails to the head, as the hair in this way offers less obstruction to the movement; and it is then called *sitting head-nerve friction.* The position of the operator and patient will be seen by Fig. 33.

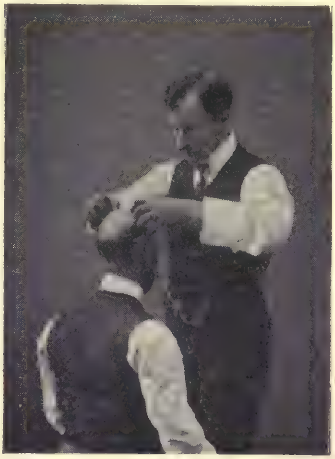

Fig. 33.—Sitting head-nerve friction.

Friction has a stimulating effect upon the nerves, and is also applied to other parts than the head, following nerve-routes.

Group X.

LIFTING, EXPANSION, AND HEAVING.

A. LIFTING is a movement specially intended to improve respiration, and so affect certain organs in the chest. All heart disease may be beneficially treated thus, the movement being most suitable for very delicate patients with severe affections of the thoracic organs, particularly the heart.

The operator can always work best from behind, and varies his grip from underneath the arm-pits (Fig. 35) to over the shoulders to the arm-pits, according to the height at which the patient sits.

If the case is treated in bed the operator will take the latter grip (Fig. 34). In all cases care must be taken that the lifting is a "chest-lifting," and not one of the arms.

The liftings, however, are frequently performed in successive planes, thus: (1) lifting and sinking in the frontal plane; (2) lifting and sinking in the sinistral plane; (3) lifting and sinking in the dextral plane; the rotation out of one plane into another being performed at the end of the sinking. Inspiration accompanies lifting; expiration accompanies sinking.

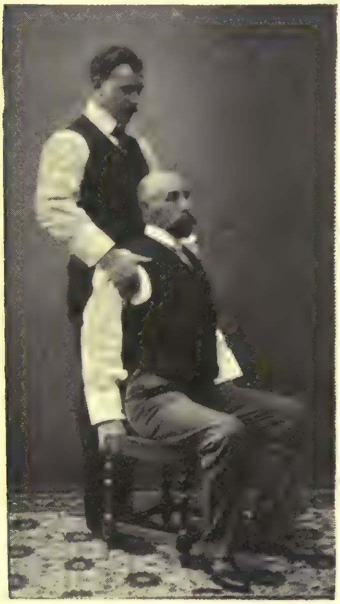

FIG. 34.—Chest-lifting.

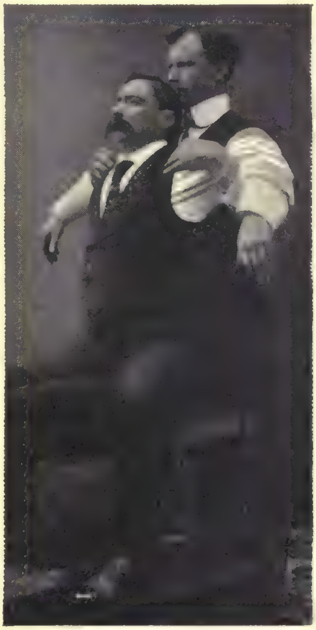

FIG. 35.—Heave-sitting chest-expansion.'

During another form of the same movement the rotation from one plane to another may take place simultaneously with the sinking, the breathing being regulated as before.

When rotation is included, to make the liftings in different planes, the grip shown in Fig. 34 has to be taken.

Note.—The object of the "different planes" is to take effect upon sinking-in of one-half of the chest; as, for example, in cases of pleural exudation, or when the appendices of the lungs are affected with emphysema, to secure as full inspiration and expiration as possible.

The above movements are called *sitting chest-lifting* and *sitting chest-lifting in different planes.*

There are other lifting movements in medical gymnastics designed as treatments for uterine prolapsus, and also on the sigmoid flexure of the colon in prolapsus of the rectum. This branch of treatment was developed by C. Brandt in his gymnastic method.

B. EXPANSION is exclusively used for chest treatment in diseases of the respiratory organs, bronchial and heart affections; and when no organic disease exists, it is highly beneficial as a respiratory movement.

(i. 1) *Heave-sitting chest-expansion.*—The operator stands behind the patient, whose trunk is supported on the chest of the former (Fig. 35). The upper arm a little above the elbow is gripped by the operator, and the arms moved in a backward and slightly upward direction. Breathing, of course, is regulated as in lifting.

The inspiration may, as in all respiratory exercises, be completed, so far as the patient is concerned, before the movement is finished by him; but that part of the act of chest expansion performed by the operator pressing the subject's arms upwards and backwards will make room for an automatic inflow of "supplementary air."

Chest-expansion is used to correct flat chest, rounded back, and lateral curvatures of the spine, as well as to promote respiration.

(i. 2) *Heave-grasp-standing chest-expansion.*—The subject stands between two upright poles, which he grasps, one with each hand, about the height of his shoulders. His position otherwise is that of the F. S. P.

The operator places one or both hands on the middle of the back, and expands the chest by a forward-upward pressure from behind.

C. Heaving means (1) the lifting of the body by means of the arms; (2) the lifting of the arms to a perpendicular position (arm-heaving); (3) the lifting of the body on the toes (toe-heaving).

(i. 1) *Stretch-hanging heaving.*—From the F. H. P. the body is raised by contracting the muscles of the upper arm.

Obviously this involves considerable strength on the part of the patient, and unless properly performed is much better left alone and the undernoted variation employed.

The faults usually shown in a badly performed movement are:

(1) Drooping of the head; (2) compression of the chest; (3) lifting the knees towards the abdomen; or (4) pulling the legs up behind.

With a slight aid from the operator, such as lifting the hips or legs, even delicate patients can perform the heaving, and the movement is—

(i. 2) *Stretch-hanging double-arm-heaving with leg-support.*

The operator must enforce the strict fundamental hanging position (*q.v.*), and see that the heaving is continued until the forearm and upper arm are at right angles and kept in the frontal plane.

Dr. Wide says of this movement:—"It is of considerable prophylactic importance as regards the normal development of the chest and spine; and not of less therapeutic importance when it is a question of curing rachitically deformed, flat, compressed, or narrow chest, round back, or the first stage of curvature of the spine."

Heaving is a good preventative treatment in forward-bent-head-hanging shoulders and bad carriage in general.

The common gymnastic apparatus used in this country frequently conduce to aggravate or even originate the defects above mentioned; the apparatus referred to are: hanging ropes with rings, and such appliances as allow the hands to come nearer to each other than a shoulder width.

On the other hand, there should always be found in a home where young children are to be educated a "boom" and trapeze.

(ii.) *Standing double-arm-heaving forward-upward, outward-downward.*

The subject first assumes the F. S. P., then raises the arms at full stretch, in arcs parallel to each other and distant by a little more than the breadth of the shoulders, fingers extended and closed, palms facing. When the arms have reached their full vertical stretch they are then carried from each other sidewards in arcs until the horizontal line of the shoulders is reached; here the palms which have been facing upwards are turned towards the ground before the descending movement is continued. The arms are then lowered until they reach the position started from.

Respiration must be regulated so that inspiration accompanies the lifting and expiration the sinking.

The movement throughout should be slow, steady, and uninterrupted.

(iii.) *Toe-heaving* is generally performed in the movement called

Hips-firm standing heel-raising.—The body is raised on the toes, either apart or closed, but in both cases the heels must be touching. The lifting and sinking alternately employed beneficially affects the muscles of the ankles and arch of the foot, and when accompanied by knee-bending is prescribed in cases of flat foot.

MASSAGE MOVEMENTS

To properly perform massage movements it is essential that sensitiveness of the hands should be highly cultivated, for by the quick detection of organic changes as they occur under the treated surface both the weight and direction of the movements can be regulated. This obviously can only come through long experience and knowledge of bodily structure. A certain amount of strength and energy is required in the operator's arms, and a hand neither too small nor bony is preferable.

Massage movements are not strictly included under medical gymnastics, but many of the results in both are similar, although their methods of application are different. The main forms of massage will be here treated under—

1. Effleurage.
2. Massage à Friction.
3. Petrissage.
4. Tapotement.

1. *Effleurage.*—Before effleurage is given the skin is bared and well anointed with an unguent, such as vaseline, unless where some specific secondary effect is desired, and some other preparation be used. This facilitates the movements of the operator's hand, and when heavy pressure is desired prevents irritation and pain to the skin of the patient.

Pressure, however, varies from moderate strength down to gentle stroking. The full palm of one hand, or both hands simultaneously, may be employed in the manipulation, and where the part, such as wrist or ankle, will allow, the thumb opposed to the four fingers will have a double effect. The aim of effleurage is to promote circulation in the veins and lymphatics, and therefore the direction should be invariably towards the centre, following the venous blood-flow. Obviously the greater the surface covered by the hand the greater the effect will be. The movement is generally of a slow and gentle nature, and assists the circulation in the absorption and removal of the lymph and inflammatory products.

This manipulation is principally applied in acute cases of synovitis, contusions, hyperæmia in the head (throat effleurage), and all forms of inflammation, etc. In acutely swollen parts it may be necessary to continue the movement from thirty minutes to an hour, and repeat several times daily. As an example of the application of effleurage, a case of contusion in the soft part of the forearm may be treated.

First, If the injury be newly received the effleurage will be immediately applied upon the surface actually affected, and the strokings will be continued well up the arm. The process is carried on till heat, soreness, and signs of inflammation disappear, and may be repeated with intervals varying from thirty minutes to several hours, depending upon the severity of the injury.

Second, When the treatment is to be applied some time after the receipt of the injury, and the part is already hot, swollen, and sore, so that it is very sensitive to the touch, the manipulation begins upon the parts of the limb above the area inflamed, in order, so to speak, to open the vessels. The distance from the seat of injury of the surface thus treated will be gradually diminished until direct contact with the inflamed part is obtained, and the touch of the operator's hand so light that no inconvenience arises to the patient. So soon as this condition is reached the operator's hand should pass from below the seat of injury right over the part, the pressure being there of the lightest possible nature and increasing gradually as the hand moves upwards. Each repetition should be of a gradually increasing weight until the manipulation merges into the "first" phase.

2. *Massage à Friction.*—This manipulation, as well as effleurage, is given on the bare skin, which is prepared also by an unguent. It is performed by the hand, the first phalanges of the three middle fingers, or the point of the thumb. The applied part moves in circles or in volute lines, whose general direction is centripetal. Various degrees of pressure are employed, and the maximum is sometimes considerable.

The purposes of the manipulation are to disintegrate the partially organised products of inflammation, to put the tissues into a more vigorous reactionary state, to stimulate the circulation, and so further reabsorption. Massage à friction is used as treatment for many forms of disease, *e.g.* chronic synovitis, perisynovitis, effusions in the synovial sheaths, chronic infiltration in muscles, etc.

3. *Petrissage.*—This is a manipulation performed upon the bare skin both with and without unguents. The part to be treated is taken up between the thumb on the one side and the tips of the four remaining fingers on the other, and a process of kneading, which closely resembles nipping, is carried out. Both hands, however, are also employed, and the part kneaded between them with an even pressure. When much stronger effects are desired, the hands may be closed, and the part compressed between the second phalanges of the fingers shut into a fist, as, for instance, in the treatment of the calf or upper arm, etc.

Sometimes the open hand is employed, and friction is along with pressure applied. In this petrissage resembles massage à friction.

The object of the manipulation is to take away inflammatory swelling, such as may arise in a single muscle, or even muscle-group, from chronic or acute rheumatism, in sciatica when irritation has arisen in muscles adjacent to the sciatic nerve. It may further be used prophylactically against myositis arising in overstrained muscles by removing waste products, the accumulation of which causes fatigue, or for the purpose of restoring atrophied muscles to vigour.

4. *Tapotement.*—This is a manipulation usually applied to the bare skin, and which is performed by the hand or by a "percussor." The hand is used in several forms :—(1) The two first fingers are stretched over to the ball of the thumb, and the beating is given by this "cage hand." (2) The hand may be arranged into a "saucer" shape, and so the air enclosed in the palm influences the skin. (3) The most active form is the "flagellating" hand. (4) Tapotement, or tapping, is also done, as the name suggests, with the finger-tips. The object of the manipulation is to stimulate the nerves to greater activity, or diminish their action, whether they are on the surface or deep-seated. The form of hand to be used is chosen according to the effect desired. Many of the tapotement forms resemble certain gymnastic movements already described.

Treatment of Diseases

The treatment should be timed to fall between two meals, and neither too near nor too long after a meal, so that the maximum of vigour in the patient may be taken advantage of.

Some cases have been selected to aid in the illustration of the application of movements to the cure of disease.

Disorders of Circulation.—Case 1.—*Noises in the Head of Sixteen Months' Duration.*—Miss A., age 52, stoutish, easy circumstances, accustomed to good living, in habit of taking stimulants with food for many years.

On examination :—

1. The muscles of the front of the throat were much contracted, the muscles on the neck stiff.

2. The jugular veins were hard and tender to the touch, and the parts about them swollen, particularly on the left side; the patient complained of pain experienced in turning the head, and the noises were worse when she was lying down.

From these facts, and the history of the case, it was evident that the circulation was the cause of the buzzing, and accordingly the following course of general and local treatment, extending over six weeks, one visit per day of sixty minutes' duration, was carried out :—

(*a*) Sitting-chest-lifting; (*b*) Half-lying double-foot-rolling; (*c*) Half-lying double-leg-muscle-kneading; (*d*) Yard-sitting double-arm-rolling; (*e*) Double-arm-muscle-kneading; (*f*) Head-rolling and rotation; (*g*) Mechanical vibration on temples, round ears, and on the ears; (*h*) Neck-effleurage; (*i*) Abdominal-kneading; (*a*) repeated.

After treatment on the 1*st day* the patient felt comfortable, and tightness about the head gone. This feeling lasted for several hours.

On the 3*rd day*—buzzing gone for two hours, improvement continued.

By the 10*th day* the swelling about the jugular veins was much reduced; buzzing absent from 11 A.M. to 10 P.M.; complexion improved and spirits brighter.

15*th day.*—Swelling in throat almost imperceptible; buzzing recurring only in the early morning; general tone still keeping up.

At the end of six weeks' treatment swelling disappeared, buzzing continually absent for fifteen days. Her medical man found the "general condition much improved, and the heart is more vigorous and more nearly normal."

CASE II.—*Fatty Heart.*—Mr. B., aged 55, married, very strong, sound constitution, stout, seventeen stone weight, merchant, hard worker, but takes no exercise, heavy eater, but moderate with stimulants; had been in good health until the last ten years, when shortness of breath and feeling of compression over the heart appeared. During three months immediately preceding his coming to me heart symptoms gradually growing worse, until he could not walk even a few hundred yards without stopping several times to recover breath. For many years had been taking drugs by order of his physician, but had not kept to restricted diet as ordered.

When the case came to me he was in a rather weak condition, and therefore only passive manipulations were given: (*a*) Respiratory exercises; (*b*) Foot, hand, arm, and leg rolling; (*c*) Kneading on the extremities; (*d*) Local heart treatment.

Visits daily for twelve days, one hour a day. Patient gradually improved in vigour and in power of breathing, compressed feeling abating; movements were gradually increased in strength, walking exercise daily, orders as to diet strictly obeyed.

The following standard of movement was reached in four weeks, and continued till the case concluded in eight weeks from beginning:—(*a*) Heave-sitting chest-expansion; (*b*) Half-lying leg-rolling, flexion and extension; (*c*) Yard-sitting forearm flexion and extension; (*d*) Heave-grasp-standing chest-expansion; (*e*) Half-lying knee flexion and extension; (*f*) Yard-sitting double-arm-rolling; (*g*) High-ride-sitting trunk-rolling; (*h*) Half-lying abdominal-kneading; (*i*) Half-lying heart-hacking and clapping; (*a*) Heave-sitting chest-expansion.

When the course of treatment was finished, the patient could walk without breathlessness four to five miles at a stretch, his weight was reduced, no feeling of restriction in the chest remained, his general health was improved, he returned to work, and at date, a year since the treatment, does his daily duties and feels very fit.

All heart diseases can, in general, be beneficially influenced by a well-chosen medical gymnastic day-order. The work of the heart has to be lightened by the artificial help of exercises acting upon the circulatory system, as weakened circulation is a necessary consequence of heart disease.

The three groups of manipulations intended to equalise the blood-pressure and to diminish venous congestion are—(1) Rollings, (2) kneadings, and (3) respiratory movements.

It is also possible, as in the case of fatty heart, to urge the organ to increased activity, by exercising in slowly graduated passive movements, until a power of performing active exercises is reached by the patient, which are in turn increased in strength so far as the operator judges fitting. Caution, however, above everything must be observed, or fatal results may follow. The special efficacy of passive movements upon the heart's action may be here briefly referred to:—

1. *Rollings.*—The forms of rolling used in heart diseases are foot-rolling, leg-rolling, hand- and arm-rolling, trunk-rolling, and head-rolling; and these, by stretching the venous vessels, cause them to increase their holding capacity, and, in turn, to deplete themselves and fill again. The whole effect, from the various parts being taken up as above, not only increases the quantity of blood in the part for the moment, but accelerates the flow by the pumping towards the heart, equalising the supply throughout the system, and relieving the heart of strain. Special importance is attachable to rolling in the shoulder and hip-joint from the

proximity of the great veins, in which a strong suctional effect is set up by the rolling, and also by the fasciæ, which are slightly attached to the veins, being drawn taut and slackened alternately. These two movements are called the venous pumps.

Arm-rolling in heart-disease cases should never be carried over the horizontal plane.

Trunk-rolling influences the flow in the vena cava superior and inferior, the latter more than the former on account of the reciprocal mobility of the vertebræ in the lumbar region admitting of the rolling taking strongest effect there.

Head-rolling should be moderately given in heart cases, both as to extent of the sweep and time. It has a great influence on the venous system of head and neck, and is particularly beneficial in cases of congestion in the head.

2. *Kneadings* in muscles and abdomen have already been referred to in the introduction as furthering the circulation. The latter causes, in addition, a mechanical excitation of the nervi splanchnici which brings about a contraction of the great abdominal arteries, and also of the vena cava inferior and the venæ portæ.

3. *Respiration* has been fully treated already, and its effects on the heart and circulation are sufficiently known. It is apropos here, however, to state that heart cases should always be instructed to respire slowly, easily, and fully.

Dr. Levin, Stockholm, has collected statistics on 6000 pulses during a period of ten years, which give the following conclusions:—(*a*) The pulse always sinks during a rational treatment. (*b*) The pulse, if the treatment lasts a long time, gradually sinks, to rise again when the treatment ceases. (*c*) Certain movements have proved to be pulse-diminishing. (i.) Heart-tremble-shaking, 8-12 beats per minute; (ii.) Chest-lift-shaking, 9-10 beats per minute; (iii.) Abdominal-kneading, 8-10 beats per minute; (iv.) Back-tremble-shaking, 7 beats per minute.

Local heart treatment is given in the common forms of—(1) Stroking, (2) hacking, (3) clapping, (4) tremble-shaking.

Stroking and tremble-shaking have been found to reduce the action of an over-excited heart by from 10 to 12 beats per minute. Hacking and clapping, on the other hand, can increase the action of a sluggish heart. One has, however, to be very careful in administering these last two movements, as they partake of the nature of shocks, which in some cases may do harm. They can, however, be gradually worked up to and given with good effect when specially required.

When patients are in a low state and confined to bed, only passive movements should at first be given in the form of foot and hand rollings and kneading on the extremities, and if necessary, abdominal kneading and local heart treatment. These may be graduated up to admit of light active movements being performed.

Heart treatment should last over one or two months and be repeated yearly.

DISORDERS OF RESPIRATION.—CASE III.—*Chronic Bronchitis.*—Miss C., 27 years, medium height, thin, and with in-sunk chest; occupation led to a good deal of stooping; unable to take sufficient exercise, anæmic, and general tone low. I treated her for seven weeks, once a day, sixty minutes at a visit. Her prescription was at first entirely of passive movements.

(*a*) Movements for expanding the chest; (*b*) Movements to improve circulation; (*c*) Movements to improve digestion.

These were graduated in strength, leading up to active movements, with which they were combined.

The patient from the first expressed her feeling of comfort derived from the treatment; and a gradual elevation of tone and general health, along with increased power of breathing, was daily observable. At the end of the seven weeks the form of the chest was improved, and its dimension under the arm-pits increased 2¾ inches. She resumed work, and has continued for a year taking daily exercise as prescribed by me when treating her, and has never had a return of symptoms. In appearance she is improved, and feels stronger than before her bronchitis treatment.

Prescription gradually introduced for first fortnight.—(*a*) Sitting chest-lifting; (*b*) Half-lying foot-rolling, flexion and extension; (*c*) Half-lying chest-lift-shaking; (*d*) Yard-sitting double-arm-rolling; (*e*) Arm-lean-standing back-hacking; (*f*) Half-lying leg-rolling; (*g*) Hips-firm ride-sitting alternate-twisting; (*h*) Heave-grasp-standing chest-hacking; (*i*) Sitting-chest-lifting. After every movement, standing double-arm-heaving outwards (with deep inspiration), and downwards (with full expiration).

Prescription for rest of time.—(*a*) Heave-sitting chest-expansion; (*b*) Half-lying double-arm-rolling and flexion; (*c*) High ride-sitting trunk-rolling; (*d*) Heave-grasp-standing chest-expansion; (*e*) And chest-clapping; (*f*) Hips-firm ride-sitting screw-twisting; (*g*) Leg-lean-standing double-plane arm-carrying; (*h*) Half-lying knee flexion and extension; (*i*) Standing chest-clapping during double-arm-lifting outward-upward; (*j*) Heave-sitting chest-expansion. After each movement, standing double-arm-lifting forward-upward (inspiration), and sinking outward-downward (expiration).

Chest-lifting and expansion, and Double-arm-heaving, are the most important of the movements intended to make inspiration fuller and deeper, and to stimulate pulmonary circulation. They expand the whole chest uniformly, but in cases of sinking-in of one-half of the chest, *e.g.* after pleurisy with exudation, special exercises may be employed to act upon the weak half.

Side-flexion towards the healthy side and *chest-lifting in different planes* will effect great improvement. Side-tremble-pressing and chest-lift-shaking are among the most beneficial movements in cultivation of *expiration.*

To increase the mobility of the chest, side-ringing, screw-twisting, trunk-rolling, alternate-twisting, and arch-flexion backward in the dorsal part of the spine are, for example, among the chief means employed.

In lung emphysema (where the chest assumes a barrel shape, stiffens, and loses power of full expansion and contraction) the relative suppleness of vertebræ, ribs, sternum, and their articulations, is gradually lost; the shallow breathings have made the habitual posture of the whole thorax a cramped one. The movements above named will be found useful in restoring normality, and they will also be of great assistance in restoring mobility of the chest in cases where no organic disease is present, viz. in rounded back and flat chest.

In all bronchial cases the *mucus* is a troublesome factor, and it has been found that "chest-tremble-shaking, hacking, and clapping" are potent in loosening the mucus from the bronchial mucous membrane, promoting expectoration, and exciting the muscles of the respiratory act to more energetic functioning, a desirable thing when muscular atony is threatened from weak and shallow breathing.

It is sometimes necessary in lung and bronchial cases to deplete the over-abundant supply of blood in the lungs, and this is accomplished by active and passive leg movements, as being the strongest and most convenient forms of movement.

Nose-bridge-shaking, larynx-shaking, along with *effleurage,* are beneficial in cases of chronic catarrh in these parts.

Case IV.—*Constipation and Dilatation of the Stomach.*—Mr. D., age 37, robust constitution, great sportsman, legal profession, very hard working, temperament keen, married.

Seven years previously had suffered from a severe chill, which had left its mark on him. His physician, in sending the case, explained that he had been a victim of indigestion and constipation since chill above mentioned, and had been treated by him, also by various experts, but without satisfactory results. By degrees his strength fell until he was "skin and bone"; his bowels never acted normally—several pills and injections were taken daily—great pain was suffered in the stomach and from the accumulation of gases in the abdomen.

On his coming to me for first treatment I found the abdomen distended with gases; that no motion had taken place for forty-eight hours; that five or six pills had been taken that day without result; the stomach dilated and pained by a touch; pulse weak.

The prescription for the first week consisted of—(*a*) Leg-rolling; (*b*) Stomach-pit-shaking; (*c*) Stomach-shaking; (*d*) Abdominal-kneading; (*e*) Colon-stroking.

1*st day.*—Treatment of one hour's duration given at 7.30 P.M. Gases fairly well removed; patient more comfortable; bowels moved at 12.30 A.M.

The patient felt better at end of first week. Motions were obtained every day, but not without drugs.

From 7*th day* the movements gradually increased in strength. The patient came to me daily; formerly I had visited him. The "pills" were gradually reduced in number, until at 10*th day* he had reached one per diem.

On 18*th day* the pills were reduced to one per two days, and gradually were reduced until from 58*th to* 70*th day* (end of treatment) no pills were used, and daily motions were established.

At the end of the second week the improvement in general health was very marked; the gases, though accumulating daily, were much reduced in quantity; stomach became more vigorous.

When the course of treatment terminated the patient had put on flesh, improved in colour, digested well, the bowels acting freely, and had resumed his usual duties. The special diet of his physician was continued throughout.

He took outdoor exercise, bicycling included, and walked two to three miles daily. Four months after the treatment the case continued in good general health, and also in regard to the digestive organs; it was then lost sight of.

After the first week the prescription followed was:—(*a*) Half-lying double-arm flexion and extension; (*b*) Half-lying leg-rolling plus; (*c*) Half-lying leg up-drawing and outstretching; (*d*) High ride-sitting trunk-rolling and backward-falling; (*e*) Arm-lean-standing sacral-beating; (*f*) Half-lying stomach-pit-shaking; (*g*) Stomach-shaking; (*h*) Abdominal-kneading; (*i*) Colon-stroking; (*j*) Respiratory exercises (*vide* (*a*) below).

A prescription for home exercising to be followed once a day, and noted below, was given concurrently with the treatment, and was also followed out by the patient after leaving me:—(*a*) Standing double-arm-lifting outward to horizontal position (deep inhalation), sinking (full expiration), six to eight times; (*b*) Hips-firm toe-standing knee flexion and extension, three times; (*c*) Standing double-arm flexion and extension upwards-outwards-downwards, four times; (*d*) Hips-firm stride-standing trunk-rolling, three to five minutes; (*e*) repeat (*a*).

CASE V.—*Constipation with Intestinal Atony.*—Mr. E., aged 69, retired, sedentary occupation, never took much exercise; for many years had suffered from constipation, which at last had become so bad that the fæces were dry, hard, disconnected, and the size of small marbles; laxatives had little or no effect, and the fæces were extremely difficult to get out with enemata; from this I concluded that they lay deep within the sacculi of the atonic intestine, and by colon-stroking and kneading they were soon felt on palpation.

The treatment lasted for two months with one visit of thirty-five minutes daily. Attention was directed to establish peristalsis and secretions, and to strengthen the abdominal muscles and accelerate the circulation.

Abdominal-massage, leg-rolling, knee up-drawing and down-pressing, and sacral-beating, with occasional *trunk-rolling*, gradually produced strengthened intestinal action, which showed in improved motions, the fæces becoming by degrees more cohesive.

Home treatment was administered according to my prescription by the patient's niece. He began open-air carriage-driving twice a week or so, and walking daily, and has kept up his improved condition. Two years have elapsed since treatment.

As will have been noticed by the frequent reference in digestive organs treatment to stomach-shaking and stomach-pit-shaking, great importance is attached to these movements. The mechanical irritation caused by them produces a livelier secretion of the fluids involved in the chemical process of digestion, activity in the stomach itself, and a better mechanical mixture of the contents of the stomach, which are more rapidly emptied into the intestines.

The latter result is directly beneficial in cases of dilatation of the stomach, and it will be noticed that patients who have been treated in this way readily show signs of returning appetite.

The intestines are more acted upon by those movements which accelerate reabsorption, *e.g. abdominal-shaking and transverse abdominal-shaking,* which have already been referred to as aiding in removing mucus in cases of intestinal catarrh.

From Case V. quoted above, the particular advantages of *colon-stroking* and *abdominal-kneading* in the therapeutic treatment of constipation, conjoined with intestinal atony, will be seen; and similar effects may be produced by active movements when the patient is strong enough to take them. The active circulation of the blood in the pelvic and abdominal organs, accompanied by fuller digestive function, are particularly insured by *abdominal-kneadings, trunk-rolling and leg-rollings.*

Chronic catarrh of the stomach can be beneficially treated by *stomach-pit-tremble-shaking* and *stomach-pit-shaking.* Care should, however, be taken that the pressure of the operator's hands does not aggravate the sensitiveness of the part.

Abdominal-kneading is of great assistance to the above-named movements. It is advocated that when pressure can be brought to bear on the cœliac plexus (in the movement of stomach-pit-tremble-shaking) a very much enhanced therapeutic value accrues in chronic catarrh cases; but as it is very difficult to exert pressure so deeply as the cœliac plexus lies, particularly in stout patients, therefore it is difficult to judge the exact value of this claim.

It will be found advisable in cases where chronic catarrh shows in persons who have not got much muscular power and who live well, to give a general gymnastic treatment in addition to the movements specifically designed to affect their ailment. The abdominal muscles in such cases should be specially attended to as a prophylactic.

In cases of neurosis of the stomach medical gymnastics in many cases can be advantageously given. Pressure upon the part is the usual recourse of the patient himself, and gives a clue to the curative treatment. When a lasting effect is wanted mere pressure will not avail; *stomach-pit-tremble-shaking and tremble-pressing stomach-shaking and abdominal transverse stroking* should be applied and with a fair amount of strength.

In chronic diarrhœa it has been found that gentle *continuous strokings with vibration* have had an alleviative effect both upon the pains and the frequency of discharge. The intestine is assisted in recovering its reabsorptive powers; the fluid matter in the intestine being removed, the fæces assume a stronger consistence. Depletion by means of leg-movements has also been found, when accompanied by the above movements, to have a good effect.

Trunk-movements must be strictly avoided.

Colic-pains, so frequent in young children as well as older people, and usually found in intestinal catarrh, can be readily removed by the above means. Stroking-vibration all over the intestines will be found a beneficial treatment for colic in infants, even during the first few months, and as this can be readily done by the mother or nurse, it should be recommended instead of drugs.

Constipation, generally speaking, is a disorder in which medical gymnastic treatment is pre-eminently successful, for, no matter how long-standing the disorder may be, no harm can accrue, and in the great majority of cases success is attained even when aperients, purgatives, and injections have shown themselves ineffective.

As we have already stated in various parts of this article, this ailment may arise from various causes, chief of which are deficient mechanical aids to digestion, bad circulation, disease in the central nervous system, atony of the intestine itself, weak abdominal muscles, or mechanical obstruction; and as has also been pointed out, there are specific gymnastic movements, both active and passive, designed to affect these individual causes, it should be a matter of everyday practice on the part of a skilled operator to restore natural functions by these means. It should, however, be mentioned that if a lasting effect is aimed at in this disorder, the course of treatment should be continued beyond the first signs of improvement, and a prescription for self-manipulation at home should be followed by the patient in order to make permanent the benefits secured by the treatment. The movements most easy for self-application are abdominal-kneadings, colon-strokings, and certain active exercises to strengthen the abdominal muscles.

DISEASES OF THE LIVER.—Manipulatory treatment of the liver and such exercises as increase respiratory movements will have a mechano-therapeutic influence upon that organ.

Liver treatment should involve the gall-bladder, as the interconnection of liver and gall-bladder is very close.

The chief forms of manipulation employed are—

(1) *Abdominal side-shaking* applied to the region of the liver, accompanied by the fullest inspiration.

(2) *Vibration* above the organ, followed by

(3) *Muscle-kneading* on the back above the liver, and *tapotement* on the same part.

(4) *Trunk-movements* in general and *abdominal-kneading.*

Treatment should be given from two to three hours after a meal, when the chyme is passing into the duodenum.

It has been allowed by eminent medical authority, even in this country, that manipulatory treatment not only is efficient in torpid liver, but also in cases of removal of gall-stone from the duct, and that it has not got the drawback of risk of death which attaches to a surgical operation.

Liver complaint may be due to a variety of causes: sometimes the bile-ducts are blocked by catarrh, calculi, or spasms; or more commonly the disorder may be due to venous stasis arising from bad circulation in the liver brought on by heart or lung disease, or from an excessive supply of blood to the liver, the result of too high living. How active exercise as well as manipulatory movements can affect these is already, from what has now been stated, sufficiently obvious.

DISEASES OF THE BLADDER can be treated for directly and indirectly. The direct methods applied to the bladder through (1) the abdominal parietes, (2) the perineum, and (3) the rectum, have been explained under movements; the indirect methods come under the group of depleting leg-movements, trunk-rollings, and other specific movements.

(1) *Bladder-massage through the parietes* of the abdomen is given usually in cases of atony and paresis and chronic cystitis, when the musculus detrusor urinæ requires to be affected.

(2) *Perineal massage for the bladder* is of less direct effect than through the rectum, and less frequently applied, but from its ease of self-application it is recommended to patients suffering from paresis or prostatism.

(3) *Massage through the rectum* applied with "injector" is the most effective method in obese cases, and is used in treating for paresis, enuresis, and prostatism.

In enuresis the head of the "injector" should be just behind the symphysis pubis; but in prostatism should reach even beyond the prostate. The shaking, stroking, or vibration should move from side to side, and be regulated by the endurance of the patient; and the "injector" should be gently and steadily pushed forward during the whole operation.

Frequently it will be found necessary to use the finger instead of the "injector," particularly in delicate cases, and where doubt exists as to the condition of the rectum.

The indirect treatment consists chiefly of *depleting leg-movements*, e.g. *leg-rolling, leg-twisting, leg up-drawing* and *out-stretching. Trunk-rollings* and *sacral-beating* will be found beneficial in some cases.

Retention of the urine, a common variety of bladder disorder, may be due to cramp of the sphincter vesicæ or paresis of the musculus detrusor urinæ; and massage treatment is beneficially used for these disorders, as both nerves and muscles may be, by excitation, urged to normal functioning.

While massage will relax the cramped sphincter vesicæ, it obviously would be of no use, or might do harm, if applied to the detrusor muscle when in that state.

Failure to retain urine, common enough and not alarming in children below three years of age, disappears gradually after three in robust cases; but where it still persists, can be treated, and generally with success, by movements designed to strengthen the sphincter vesicæ.

In most cases this can be done through the rectum, by the finger being pressed steadily toward that muscle, while shaking from side to side takes place.

General strengthening of the whole system and the training of the will-power of the child should be carried on simultaneously with the passive movement.

As a preventative against paresis, care should be exercised in adults, as well as children, to avoid compulsory retention of urine after the feelings of necessity arise, as very distressing consequences may ensue.

It must not be assumed that manipulatory treatment is advocated for all cases of disease of the bladder, *e.g.* diseases depending upon infection and contagion; and such disorders as ulcers, tubercle, all kinds of morbid growth and foreign matter in the bladder, must be treated by other means.

As stated in the Introduction when treating of nervous diseases generally, certain forms of paralysis can be successfully treated by manipulatory therapeutics; but the warning must here be reiterated that no gymnastic treatment should be begun until a complete medical diagnosis has been given.

Even after Swedish treatment has been decided upon, it is essential to the proper management of the case that the operator should be qualified to judge of variations in the prescriptions to suit individuals, as in this kind of disorder, as in others, no prescription can be written to suit all cases. The treatment which brings good results should be frequently repeated; and as is often the case, benefit to the patient bears a direct ratio to the amount of energy put into the work by the operator, non-success may not necessarily condemn the process, but rather the insufficiency of the vigour put into its application. Diseases of the nerve-centres in particular should be persevered with laboriously before the opinion of their incurableness be entertained; and no one has, therefore, the right to set aside manipulation as a cure in nervous disorders until he has followed the history of a variety of cases undergoing this treatment.

The treatment ought to be directed, first, to restoring the diseased muscle or nerve to its proper function, and along with this a general treatment for the system will have a reflexive influence for good both upon these parts and the manipulations applied to them.

Extra strong muscle-kneading and clapping and stroking applied to extremities have been found a good preparation (in cases of paralysis and atrophy) for the specific manipulation of *muscle-massage*.

In applying this last movement the muscles may be operated upon individually or in groups, according as they lie accessible to the hand. In *nerve-pressing*, which follows, the paralysed nerves are sought where they lie nearest to the surface, and where they can be pressed against a hard underlying part. The whole treatment usually concludes with strong *effleurage* to excite the peripheral nerves in the skin.

Atrophy and hypertrophy of the skin and subcutaneous tissue can be readily detected by the unhealthy hue, coldness, and lack of elasticity; and to restore normality in these conditions is the proper function of effleurage, for improved circulation furthers the nutrition of the tissues.

Before the diseased centre can be restored to health it is essential to arrest atrophy in the periphery, and, as is claimed for manipulatory treatment, send nutrition from the restored periphery to the diseased centre; and to secure this every muscle, nerve, vessel, joint, or other part of the affected limb must be put through such a course of passive treatment that their proper normal functioning will be so closely simulated that peripheral health and its reflex influences upon the centre are gradually established. For until such time as the centre is capable of functioning, it is necessary to keep the peripheral parts in a healthy condition, so that they will be able to respond to the centre when that part gives the command. Every sign of response in the atrophied limb will be looked for and taken advantage of to form resistances to the passive movements, and so graduate into movements which are purely active.

In the complete establishment of active movements lies *cure;* hence the great importance of active movements over duplicate as a result of treatment, and of gymnastics over massage and passive manipulations as therapeutic agents. This will be more apparent when paresis of the extensor muscles of the forearm is considered, the flexor muscles being, as a result, abnormally contracted. When the extensors show the smallest sign of power they should be employed in making such duplicate movements as will shorten the extensors and lengthen the flexors. At the point where the muscle ceases to have a contracting power the passive movement should begin and complete the operation. This "mechanical encouragement" of the atrophied extensors soon bears fruit in gradual recovery of the power to make active movements.

Should the flexors, however, be allowed to retain or increase their contracture unchecked, the result will be that the hand will first be only capable of being opened by force, and finally the flexors will atrophy, and the power of contraction be lost. The whole limb will then be rendered useless.

In paralysis of the trunk, as in paralysis of the extremities, the order of treatment is similar. The loss of co-ordination in tabes dorsalis, chorea, tremor (forms of nervous disorder), have also been beneficially operated upon by gymnastics, and the ataxy in tabes dorsalis has been treated successfully by double-sided movements.

Disorders of the sensory system have also been prescribed for in the gymnastic cure. Anæsthesia is specifically treated with hackings, clappings, and nerve pressings, in order to excite the nerves in the skin; while in hyperæsthesia and neuralgic pains of a shooting and of a constrictive nature, *nerve frictions* along the nerves followed by powerful strokings on the affected part have proved efficacious.

Nervous diseases which show in tremors and twitchings should also have the benefit of *nerve-stroking and frictions,* since many cases of both alleviation and cure have in this way been obtained.

Among peripheral-nerve diseases, *motor paresis, cramp, and neuritis* have been successfully treated by gymnastics; while in the sensory system, in *neuralgia* and *anæsthesia,* good results have been obtained.

CASE—*Piano-Playing Neurosis.*—Miss J., 33 years of age, of delicate constitution and nervous disposition; much given to piano-playing as a pastime; had a course of training at Dresden Conservatoire five years before being treated; played from four to six hours daily there for a year; kept up playing a good deal during the intervening years. While in Dresden she felt pains in the right arm, and took massage there for two weeks; on the symptoms disappearing she gave up the treatment.

The pains in the arm returned soon after coming home, but were disregarded until they became more serious and interfered with performing. She was sent to me for treatment. Her right arm became numbed after a short time of playing, and could not be used for some hours. She could not move the ring finger strongly enough in striking a note; if she forced it by effort of will, acute pain would follow, on which account she left off playing with this finger and used the others. In her right side, from neck to foot, she felt numbness, and occasional prickliness all over the body; neuralgia in the head, headaches, and insomnia almost chronic. By examination I found her nervous system run down; she jumped at slight sounds; C. scoliosis; the muscles of the right arm atrophied and tender to the touch in places, and the right wrist slightly swollen.

On beginning treatment piano-playing was entirely stopped; house-work, needle-work in particular, and writing were also stopped. Daily walking in the open air up to the limit of fatigue, and resting after each meal, were advised.

Massage was given locally, including direct nerve manipulation and gymnastics, both generally and locally, daily, for thirty-six times.

On the twenty-sixth day she was allowed to resume piano-playing, using all the fingers, but only for five minutes, which was gradually increased until fifteen minutes. This length of performance was continued for a month. From that date she was advised to increase the time gradually, and to stop on the first signs of fatigue, local or general.

When the treatment was finished, the numbness, prickliness, neuralgia, and headache had disappeared, the insomnia abated. Her general health, though improved, was not quite perfect, but the patient felt no fatigue or pain from the amount of playing allowed.

One month after treatment ceased she was still progressing favourably, and was carrying out a prescription of massage and gymnastic movements, which she intended keeping up.

From the excessive strain put upon one set of muscles, either in labour or in games, several forms of nervous or muscular disturbance arise, usually accompanied by myalgia or neuritis. That the cause of the disorder is excessive use of one part is supported by the fact that the majority of instances of this arise in mechanics in middle-life, habitual cyclists, and tennis-players, professional pianists, type-writers, clerks, and compositors. Trade neuroses are of three kinds—spasmodic, tremulous, and paralytic.

The first, as illustrated by "scribbler's cramp," may show in the clutching of the fingers upon the palm (flexion cramp), or in the lack of power to close the hand upon the pen (extension cramp). The second is perhaps most typical, and gives rise to the term "scribbler." The trembling characteristic of the disorder may be induced even in a healthy person, as is shown in the handwriting performed immediately after excessive strain induced, say by sawing wood for an hour. The symptoms commonly exhibit themselves only in one particular movement (the habitual one) and in no other.

The third form, while appearing only when one particular movement is being performed, may gradually, from neglect of the disease, extend to all operations performed by the affected limb.

Massage and gymnastic movements (passive and duplicate and active) have been applied with success to such cases, and where loss of co-ordination is also involved, double-sided movements, as previously advised, with such an amount of resistance on the part of the operator as will equalise the exercise to each of the two parts, will be found specifically beneficial, as *e.g.*, double-arm flexion and extension, double-arm-lifting, double plane arm-carrying, and double arm-flinging sideways.

Direct manipulation of the nerve is even of more importance than muscle-massage and movements, when any change is felt in the nerve itself; this will also be found efficacious when neuralgia is present even as a by-symptom.

For neuralgic cases, *hacking, nerve-frictions, vibrations, strokings,* and *massage-movements*, are usually prescribed; but in such a case as *intercostal neuralgia* massage would be of immaterial value, and consequently gymnastic movements are preferred, particularly when through chest deformity the ribs press upon the nerves, and then side-flexion towards the convex side, chest-lifting in different planes, and hanging, etc. are of direct use. *Neuralgia in the joints*, or joint-neurosis, is frequently found without any anatomical modification in the joint itself or in the vicinity. The intense pain is usually accompanied by atrophy in the whole extremity. Movements are in these instances of more importance than massage.

CASE X.—*Sciatica treated by Dr. And. Wide* (1890-91).—The case is chosen to show the importance of gymnastic movements where surgical operation did *not effect* cure.

Mr. K., 20 years of age; symptoms of sciatica of varying severity had extended over three years. In the patient's opinion this had arisen from very trying acrobatic gymnastics, or from wading in water.

At the beginning of the treatment there was constant ache in and along the great sciatic nerve, which was treated by very hard massage and electric treatment given for fifty days without any marked improvement. Three months later, as the pain increased, nerve-stretching under chloroform was given, but without result. Two weeks later nerve-stretching was performed after surgical operation.

The patient was now free from pain while in bed, but as soon as he got up again it returned with renewed severity in both hip and leg, more tenderness in the nerve itself, accompanied by stiffness of the whole limb. The leg gradually atrophied, and tenderness over the lumbar vertebræ set in. Gymnastic treatment was advised by Prof. Berg, who had performed the nerve-stretching. The patient was treated exclusively with leg-movements, both passive and duplicate, daily for three months, when he had considerably improved; and for other three months on alternate days or thereby, when he was so far restored that further treatment was superfluous.

Five years later he was still in good condition; sometimes a little pain is felt in the right hip, but nothing to be compared with the violent pains felt before. The right leg is somewhat weak and slightly atrophied (1896).

As has been stated above, tabes dorsalis can be symptomatically treated by double-sided gymnastic movements, and therefore, as many other disorders follow from or accompany this disease, gymnastic treatment should always be recommended, for much relief can be given to the patient even though the disease will not be cured.

In spinal irritation (although there may be no change in the spine itself, nor tenderness to pressure), which is often looked upon as an hysterical tendency, considerable pain may be experienced as arising from the spine, and radiating outwards to any part of the body. General gymnastic treatment, as well as manipulations local to the spine, have been found of great benefit.

It may be worthy of remark in passing, that many cases which, by the symptoms described by the patients, seem to indicate heart disease, abdominal and uterine complaints, hip-joint disease and spondylitis, and many other nervous disorders, are really to be diagnosed as cellulitis (see article "CHRONIC RHEUMATISM," vol. x.) The pseudo-symptoms frequently mislead in a cursory examination. Even cellulitis may be in turn mistaken for myositis.

The cellulitis which appears in swelling in the subcutaneous tissue in the chronic stage is hard and firm, and resembles an organised œdema. The swellings are sometimes very tender to the touch, and the patient cannot endure clothing, and may feel compression on the chest as if the heart would stop, and becomes readily hysterical. The skin above the cellulitis is warmer than the surrounding parts, and the function of the body beneath that area disturbed.

Massage and gymnastic movements are of the greatest importance in removing the swellings, for the uncomfortable symptoms disappear as soon as the cellulitis is worked away.

Progressive atrophy of the muscles has been beneficially treated by a long-continued course of energetic muscle-kneading, along with general gymnastic movements. The treatment requires persistence until good results show.

Infantile spinal paralysis is often treated with gymnastics and with orthopedic apparatus. As the disease begins, as a rule, early in life, so the treatment should begin early; and deformity frequently taking a pronounced form the apparatus will be all the more necessary. The treatment here, as in nervous disorders generally, should be vigorous and long continued, in order that the atrophy and deformity should not get ahead of the healthy growth in the other parts, and should persist as long as the patient grows. There may even be great benefit derived from continuing the treatment some years beyond this point, as it has frequently been observed that the paralysed part continues to grow after the other parts of the body have ceased to do so.

Neurosis without known anatomical cause is frequently met with, commonly in the forms of involuntary twitchings and jerks, *e.g.* paralysis agitans, tremor, hysteria, neurasthenia, and chorea, or St. Vitus's dance. These generally derive benefit from this treatment.

Gymnastic movements for loss of co-ordination have already been referred to. These may be beneficially followed by a slow and gentle stroking of the exercised part. The treatment is generally a soothing and regulating one, consequently massage, nerve-pressing, and muscle-kneading are unsuitable, since they not only do nothing for co-ordination, but tend to produce spasmodic jerks.

CASE XI.—*Rheumatic Myositis.*—Mrs. K., 65 years of age; very stout, but on the whole healthy; suffered from rheumatism; had had massage in Nice, but only for a short time, when she recovered and returned home to Scotland. After her return the symptoms were renewed; she consulted a physician, who treated her with drugs without result, and he then recommended massage. The case subsequently came into my hands a week after the rubbing ceased.

The patient described how at first she had feelings of fatigue in the lower limbs, with pain and stiffness in the knees, shoulders, and arms. This stiffness extended to the hip-joints, and she could only take short steps, had difficulty in rising from a chair, and could not mount a stair without a strong pull upon the hand-rail, and always with pain. She explained that the rubbing had been chiefly applied below the knee, and on it.

On examination I found both ankles swollen slightly, and both knees considerably, especially so the left one; the hamstring muscles much contracted, the legs being consequently always kept in a crooked position; the muscles on arms and legs, particularly in the lower leg, atrophied. From the palpation I found myositis abundant in the inner thighs, and to some extent in the calves, gluteus, and deltoid muscles, and in the breasts. The mobility of the joints in general was much reduced, especially so in the shoulder and hip-joints.

She got six weeks' treatment of an hour a day, and after one week she was able to get out of bed a little and walk about the room. The improvement went on gradually, and after the third week she took open-air exercise, and continued that daily. When the course was finished the myositis could not be felt anywhere, pain was gone, the shoulder, ankle, and hip-joints had recovered their mobility, swelling having disappeared, and the atrophied muscles had become almost normal.

Six months after treatment the patient was still keeping in good health, and had no recurrence of any of the symptoms. My first care in the treatment was to absorb the fluid matter about the joints, and to disintegrate and absorb the myositis. This was, of course, carried on simultaneously with gymnastic movements to act on the functions generally, and specifically to restore mobility in the joints, remove contractures, and nourish the atrophied muscles.

The prescription followed after the first week, and to the end, was as follows:—(*a*) Massage, which consisted of effleurage, petrissage, tapotement, and massage à friction, where and when found necessary; (*b*) Foot-rolling, flexion, and extension; (*c*) Leg-rolling, flexion, and extension, and stretching the ham-string muscles; (*d*) Arm-rolling and arm-stretching upwards; (*e*) Leg abduction and adduction.

Sprain.—In cases of sprain to joints or muscles immediate treatment, or at most a few hours after receipt of the injury, is advisable. Active movements are at first quite unsuitable, and passive ones only to a limited extent according to the nature of the case. If hæmorrhage in a joint is threatened no movement at all should be given either passively or actively. Massage movements, therefore, are alone suitable.

When dislocation has occurred, and the joint has been set, no harm will arise from the undoing of the bandage after the first or second day, and giving gentle passive movement, which prevents the joint stiffening, a condition which may later give rise to both pains and difficulty of treatment.

Even in cases of fracture in the region of a joint, say when the radius is broken, the fixing bandage may occasionally be removed, and passive movements given with benefit.

Surgeons in this country are aware of the benefit derived from manipulatory treatment of the muscles surrounding a part upon which surgery has done all it can do, and a speedier restoration of the affected part to its normal state is thereby ensured.

The statements made above under muscular diseases in regard to the differentiation of the effects of massage and gymnastics must be emphasised in reference to the treatment of diseases of the joints. Just as stiffness in sprain cases is obviated by gymnastic movements as a prophylactic, so too in synovitis of an acute nature, while massage movements have assisted in the restoration of the normal condition of the joint by the absorption of the irritant, recourse must be had to gymnastic movements. Stiffness arising from whatever cause, *e.g.* in rheumatoid arthritis, can only to a limited extent be overcome by massage, and gymnastic movements are the remedy. And these in cases treated some time after the origin of the disorder must be of a vigorous character, and be carried on after massage has done its work.

It is only thus by a proper combination of both forms of movement that an efficient prescription can be made out. In acute joint complaints effleurage may do all that is wanted, while in chronic cases massage à friction alternated with effleurage (which should both begin and end each massage treatment) will give the best results. Tapotement, or clapping over the joint, may be resorted to in chronic cases, when the purpose is to produce a livelier reaction; but when this is of a strong nature the bare skin may be protected from the pain of the concussions by an intervening layer of cloth.

The gymnastic movements applicable to a joint must be determined by the kind of joint and its condition at the moment of treatment, and all movements proper to the joint should, within certain limits, be performed. It is best to begin with passive movements, but these, however, at the beginning of the treatment should not be carried out to the full extent which the joint will allow. Care should be exercised, *e.g.* after dislocation, that the full scope of a movement proper to the joint in its normal state should not be given while abnormal conditions subsist, but rather that the area of operation should be a middling one, afterwards to be increased.

In a very stiff joint, where only movement of a very limited range is possible, and when the patient, from timidity of the expected pain, contracts the muscles, and so practically brings treatment to a standstill, recourse may be had to the subterfuge of giving tremble-shaking or vibration throughout the whole of each movement; for it requires some degree of education to enable a person to make their muscles completely passive, the more so when pain is involved. This tremble-shaking may be applied in any gymnastic movement—flexions, extensions, or twistings. In acute joint affections the specific advantages of rollings may be best seen, and are of the greatest importance both in furthering circulation in and in increasing the mobility of the joint; and rollings in such cases, when performed carefully, give rise to no greater pain than do massage movements, which therefore they may advantageously accompany. So soon as the patient can endure moderately strong passive movements, and functioning is being restored in the part, active movements proper may be introduced and graduated into complicated ones.

In rickets, where abnormal mobility of joints requires to be limited, gymnastic movements will also be found beneficial; but here naturally the aim is to limit the area of operation, and by constantly confining the joint to a healthy normal angular rotation, to induce a permanent normality. These exercises limit the abnormal mobility by strengthening the joint capsule, the ligaments, and the surrounding muscles. Orthopedic apparatus must be regarded as a form of symptomatic treatment, and while this is certainly useful, it should always be accompanied by therapeutic movements; otherwise the normal function, instead of being restored (although certainly the abnormal mobility is limited), will be kept at best in an unprogressive condition, and usually the parts to be strengthened are rather weakened by the restrictions. The general health, too, is more likely to be retarded than advanced by the use of such apparatus alone.

Constitutional diseases, which usually arise from lack of physical exercise and disturbed functions, from which come faulty respiration, circulation, digestion, assimilation, etc., diseases of the blood, anæmia, chlorosis, hæmophilia, and all forms of general weakness arising from a disturbed metabolism, *e.g.* fatty degeneration, gout, diabetes, rachitis, etc. are included in the term.

The effects of systematised gymnastics upon the various functions of the body have been sufficiently discussed already to warrant our advising this means of treatment. Gymnastics of a general strengthening effect along with other treatments have been found of great value; but while their benefits are slow in making their appearance they are durable in their results.

Obesity, one of the most common and irritating disorders of middle life of both sexes, is generally due to want of activity, both mentally and physically. As imprudent eating and drinking, with too little work, are the chief causes of this condition, the opposites of these indicate the cure.

Dietetics, of course, come prominently into the prescription, but obviously such forms of movement, active and passive, as will remove adipose tissue and carry off effete matter from the system with celerity, rank also as important.

Since the accumulation of fat is extended over a long period of time, so the therapeutic treatment demands persistence and vigour in application. Perhaps the failure of cures for obesity lies in the mental sphere, and neither in the disorder itself nor the prescription for its treatment; for if the will-power of the subject be not roused out of its torpid condition, the treatment will be abandoned as irksome after a short period of trial only; when common-sense fails, vanity sometimes comes to the rescue.

Energetic medical gymnastics are of the greatest value as curatives.

From what has been stated throughout this article with reference to muscular movements and manipulations as aiding circulation, assimilation, and excretion, it will be obvious that *diabetes* can, by a well-chosen prescription, derive benefit from this treatment.

Curvatures of the spine, when the term denotes abnormality, suggest two main groups of deformities from whatever cause arising—(1) exaggerations of the normal curves of the spine in the cervical, dorsal, lumbar, and sacral regions, and which, when occurring in the dorsal and lumbar regions, are respectively termed *round-back and saddle-back;* and (2) deflections laterally, both simple and compound, called respectively *C.* and *S. scoliosis.*

The importance of the early discovery of such deformities cannot be exaggerated, for their bad effects are usually lifelong, and the chances of cure vary directly with their undetected duration. And since their detection is a simple matter to the trained eye, it is the duty of every family as well as school physician to take the trouble to examine the bare back of each child coming under his care at least once a year.

Care is necessary to discover scoliosis in the initiatory stage, since in a lying or hanging position the spine is compelled to assume a correct attitude; but should this not be discovered at an early period, the *C. scoliosis* will show later, and may compound itself by the spine seeking to compensate for one curvature by the formation of another, *S. scoliosis* being the result, or, if more than two curvatures are formed, *kypho-scoliosis.*

Scoliosis generally is accompanied by shortness of breath, impaired circulation, intercostal neuralgia, and modifications of the position and form of the ribs and pelvis, and shape of the chest. The vertebræ themselves cannot escape change, both in form and position, and with them, as a consequence, are involved the connecting muscles and the sections of the related ligaments.

Towards the concavity of a scoliotic curve the vertebræ, by increase of vertical pressure on their inside edge, will lose vertical dimension, and will therefore assume through time a wedge-like form. At the maximum of each such scoliotic curve the thinner the blade of the wedge-like vertebræ will be. The intervertebral laminæ undergo a similar modification, and by both of these changes the foramen will lose its circular contour and assume an ellipsoidal one.

The change of position of the units of the spine remarked above takes place even when a normal spine performs a side-flexion, for then the angle of deflection exceeds the limit of compressibility in the laminæ; the vertebræ, rebelling against what to them is an unnatural movement, undergo, at all events at the maximum of the curve, a *torsion*, the head of the spinous process moving towards the concavity. In a scoliotic spine these conditions must be more pronounced, and when they become permanent vertebral ankylosis may arise. It can, therefore, be well understood that habitual repetition, even in a healthy body, of an uncorrected gymnastic movement of side-flexion, or one where the flexion is excessive, can lead to scoliosis itself. The importance, therefore, of school gymnastics being based on physiological-anatomical principles cannot be overestimated.

The displacement of the ribs as well as of the pelvis which follows on scoliosis results in so serious interference with the position, form, and function of the vital organs of thorax and pelvis, that not only is function impaired, but many contingent diseases arise. It has been found by measurement, that in the transverse section of chest in a right-convex dorsal-scoliosis, the diameter running from right-rear to left-front exceeds the normal, while that from left-rear to right-front is less than normal; humps arising at both ends of the long diameter; and if two scoliotic curvatures exist in the dorsal spine a double thoracic deformity will be noted.

Although there are several theories of the causes of scoliosis, that which attracts most attention with reference to *habitual scoliosis* practically resolves itself into what has already been said under medium length of muscle (p. 166).

A scoliosis therefore arises when a disturbance, from whatever cause, sets in with regard to the balance of power of the muscles on either side of the spine. In a case of paralysis of one side this loss of balance is patent, when the paralysed muscles, unable to hold their own against the healthy ones on the opposite side, yield, and a convexity is formed on the paralysed side.

As has already been pointed out, many habitual bad positions arise in daily life, and many domestic occupations; and when children whose spines are still in the plastic stage are compelled or allowed to take part in such one-sided occupations as many home-industries involve, serious spinal disturbance accrues and the seeds of scoliosis are sown.

The bad habitual writing posture, where one side only is put towards the desk, the exercise of the right hand more than the left, standing upon one leg more than another, sitting so that the weight is not equally distributed between the tubera ischii, all faults common among children, and more so among girls than boys, are common causes of scoliosis. This deformity will be found in girls and boys in ratio about 8:1. If children are allowed to run free in a gymnasium also they usually indulge in those exercises of which they stand in least need, and so cultivate or accentuate deformities.

The most skilful physician cannot say with assurance, even after examination, whether a scoliosis will remain stationary, increase, or retrogress. Many medical men, unfortunately, act on the assumption that if orthopedic apparatus fails to check, and the system does not throw off this disorder, the case is hopeless. The other extreme of stating that all scolioses can be cured is fallacious. Observation leads to the conclusion that—(1) scoliosis is seldom thrown off by the system without treatment; (2) most cases of simple scoliosis can be successfully treated; (3) that scoliosis of the second degree can at least be kept stationary, and in many cases much improved; and (4) kypho-scoliosis cannot be successfully treated save symptomatically.

It has been stated by one of the highest authorities (Dr. Wide) on the treatment of spinal curvature, that "when the deviation from the normal does not exceed ·8 inch, complete improvement can be gained by treatment; if the deviation be greater too much should not be promised, for the considerable deformities that accompany such a curvature cannot always be removed."

It deserves repetition that prevention is better than cure; spinal curvatures should be taken early, in the premonitory stages, where prophylactic treatment may have a chance of being thoroughly effective.

Rachitic scoliosis, which is in its origin almost entirely confined to the first five years of life, is very often brought to show itself by the nurse carrying the child always on one arm, and a curvature which involves almost the whole spine manifests itself. Carelessness and ignorance among women, who allow their infants to be carried in a sitting position long before they are able to do so with safety, are also aids to rachitic scoliosis asserting itself. As children cannot be successfully treated by gymnastics much before the age of five years, orthopedic apparatus must be employed from the discovery of the disorder till then, after which stage movement treatment should be begun. For rachitic scoliosis a general strengthening treatment is quite as important as a local. In other forms of scoliosis than those mentioned there may exist secondary causes which strongly resemble symptoms of the latter group, *e.g.* deformity of chest which has arisen from pleurisy with effusion, when the exudation has been excessive, and collapse of the lungs has brought about collapse of the chest, and the spine has thereby been affected. The scoliosis arising in this way will show concavity toward the side of the chest in which collapse has been greater. Chest development by gymnastic movements, as soon as permissible after pleurisy, is an excellent prophylactic treatment against pyothorax and chest collapse.

There are a few cases where muscular rheumatism has caused such pain that the patient, to find ease, has allowed one side of neck or trunk to yield; and when this loss of medium length of muscle has been of long duration, "rheumatic torticollis" sets in, and a compensatory scoliotic curvature with its convexity towards the rheumatic side will arise in the dorsal region.

Special care should, therefore, be taken to remove rheumatism when it appears in a part where it is likely to lead to deformity; since in cases where scoliosis arises from rheumatic attack as referred to, the greatest importance attaches to the prompt and vigorous treatment of the disease; for if the patient be not successfully treated within a few weeks of the appearance of scoliosis, the disorder may become chronic, and then it is liable to aggravation on each rheumatic relapse.

The general curative principles in gymnastic treatment of scoliosis are—

(1) That a general systematic strengthening treatment be given for the purpose of aiding joints, ligaments, muscles, etc. to perform their several duties in retaining the body in a correct position.

(2) That special treatment be directed towards the spine to increase its mobility and to correct its wrong curvatures even by counteractions which bend it in an opposite direction.

(3) That the spine be stretched and straightened by such movements as exert tension and drawing upon it.

(4) That the deformities arising in the spine and chest be checked by direct pressure applied to the abnormal parts while movements are performed.

It is sometimes of value, especially in cases where the osseous system is weakly, to apply apparatus of some sort, in order that the benefit of one treatment be preserved until the next is given. In general, however, home exercises of such a nature as can be easily and correctly performed are always given as retentive means.

The following prescription for strengthening the spine, related muscles, and the system in general, may be suitable both as a preparatory treatment to the "local applications" and as a home exercise:—

(*a*) Double-arm heaving. (*b*) Stretch-standing double-heel-lifting. (*c*) Hanging. (*d*) Sitting spinal-raising. (*e*) Sit-lying double-arm-flexion. (*f*) Stretch-standing double-knee-flexion and extension (if equilibrium is rendered difficult wrist support is given, as otherwise the strength of the movement is lost; in weak cases wrist support should always be given). (*g*) Forward-lying double-arm extension. (*h*) Stretch-hanging or stretch-forward-lying neck-raising. (*i*) Stretch-hanging heaving (in cases where heaving is performed with difficulty leg-support should be given). (*j*) Double-arm heaving.

It is to be understood that if home exercises are to be properly performed the patient must have had some training in assuming these positions under a medical gymnast; and it will also be of great assistance that the movements be performed in front of a large mirror, so that the eye can correct any asymmetry; or another person may correct the patient while performing if the mirror be not attainable.

The following movements are quoted, not as a prescription, but as examples of the typical movements employed in the correction of C. scoliosis:—

A. (i.) Neck-firm side-lean-standing; or, (ii.) Neck-firm-standing side-flexion; or the (iii.) same in high-ride-sitting position.

In (i.) the patient leans against a bar adjusted so as to touch the maximum convexity of the scoliotic curve. The operator standing behind places a hand in either arm-pit of the patient and directs the pressure, so that the bar's resistance will act along the long diameter. Or as a variation the bar may be applied to the side of the hip, the convexity being over the bar. With one hand on the maximum of the curvature and the other in the opposing arm-pit the operator directs and regulates the pressure.

In (ii.) and (iii.) the bar is not employed; the operator's hand acts as in (i.)

(iv.) *Side-lying side-flexion.*—The patient lies on his side with his lower limbs on a plinth, where they are held firm by an operator sitting on them, or they may be strapped down. A second operator supports the patient's body, which lies beyond the end of the plinth, and performs the movement thus:—The patient has the convexity of the curvature upwards, while the operator with a hand in either arm-pit bends the body upwards.

Should the scoliosis be complicated with a dropping-shoulder as is frequently the case, the above movements should be carried through by the patient taking "neck-firm" with the hand on the dropped-shoulder side, and "hip-firm" with the other. When one hip is out of line the operator may push that hip upwards with one hand, while holding the opposing one steady with the other.

B. *Movements for S. scoliosis* generally seek to apply pressure to both convexities simultaneously.

(i.) *Neck-firm lean-standing-raising with pressure on the back.*—The patient stands in front of a bar, which is in contact with both his thighs, places his hands in "neck-firm" and bends forward; the operator, with a hand on the maximum of either convexity, applies lateral pressure during the patient's bending forward. The patient raises his body to the upright posture, while the operator resists that movement, still applying lateral pressure to the curvatures.

(ii.) *Neck-firm stoop-stride-sitting raising with pressure.*—This movement is performed similarly to the preceding, except that the patient takes a sitting position.

Note.—It may be an advantage to have two operators in the two above movements, one in front and the other behind, the former guiding and steadying the patient, the latter being concerned only with the pressure and resistance.

The above variation in the case of "dropping-shoulder" can also be here applied. A stronger corrective than one hand "neck-firm" is to have the arm attached to the dropping-shoulder stretched upwards.

For further examples of movements to correct scoliosis reference may be made to section under "Movements" proper.

In the prescription given above as a preparatory or home exercise, the hanging movement when dropping-shoulder comes in is best done by the bar being raised at the end above the defective shoulder. In an S. scoliosis (*e.g.* right-convex-dorsal and left-convex-lumbar) the left hand grip should again be higher than the right; and if the legs of the patient be carried towards his left and kept there correction will be simultaneously applied to the lumbar curvature.

When pressure is applied by the hand of an operator to a scoliotic curve the direction of it should be along what was termed above the "long diameter."

Full detail as to the different movements in treatment of the various forms of scoliosis, including round-back and saddle-back, cannot be given within the scope of this brief article; but from what has been already stated the general principles of the treatment can be grasped, and these are simply the application of stresses and strains to a flexible body.

No prescription of universal application to scoliosis cases can be laid down further than a merely general one. The individual characteristics of each case, in this as in all other diseases, must determine the treatment, otherwise it will be haphazard and dangerous.

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Serum Therapy

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An attempt will be made within the compass of a short article to give an account of the principles and practice of serum therapy.

In the first place, it is necessary to have some idea of what is meant by "immunity." It is the converse of predisposition. Some people exhibit a tendency to contract certain diseases, whilst others are proof against them. The immunity may be natural or it may be acquired. In some instances it is purely physical, as when toxic substances taken by the mouth are not absorbed by the mucous membrane of the alimentary canal, but pass out unchanged. Natural immunity may be personal or it may be racial; it may be temporary or it may be permanent. The most familiar example of acquired immunity is the unsusceptibility to a second attack of a person that has passed through certain diseases. It is well known that many infectious diseases confer on those who have suffered from them a power of resistance against subsequent attacks. Soon after the discovery of the microbian origin of infectious diseases, it was shown experimentally that if the microbe constituting the cause of the disease were inoculated into animals it would not only produce the symptoms of the disease, but would impart to the animal the power of resisting the morbific influence of the same microbe when subsequently inoculated. It was also found that the protection could be induced by the filtered and therefore microbe-free solution in which the pathogenic microbes had been cultivated, a conclusive proof that neither the original disease nor the artificial production was due to the microbe, but to the toxic substance produced by it. Later on it was shown that the blood-serum of protected animals, although destitute of toxic properties, when introduced into non-protected animals conferred on them a resisting power so great that even lethal doses of the virulent micro-organism or its toxin produced no effect. This is the basis of serum therapeutics, and the most marked results are those obtained by injecting substances derived from the blood of protected animals into the circulation of those not protected.

The preparation of an immunising substance is attended with much difficulty, and a potent antitoxin may take many months to prepare, the process involving technical difficulties which can be overcome only by those thoroughly conversant with the subject. The toxin is usually obtained by growing the bacilli in a flask containing nutrient broth, to which ½ per cent chloride of sodium and 2 per cent peptone have been added. The fluid freed from micro-organisms is injected. A small dose produces no dangerous symptoms, but suffices to ensure the formation of sufficient antitoxin to neutralise the poison. After a time a second and larger dose of toxin is injected. This is partly neutralised by the toxin already formed, and the surplus stimulates the production of more antitoxin. The process is carried on cautiously until there is enough antitoxin in the circulating serum to render harmless what would otherwise be a bitter dose of the poison. The animal is then "immune," and the immunising serum from the animal is injected into a patient as a therapeutical agent.

The curative value of a serum is in direct relation to its protective power, and to obtain an active serum the animal must be endowed with the highest degree of immunity. To procure a serum of this description horses are employed, which may be inoculated either with gradually increasing doses of the toxin or of living or dead bacteria. This must be done slowly and cautiously, but by following out this principle a serum of maximum intensity is obtained.

Each antitoxin affords protection only against the particular disease to which it is antagonistic. For example, the antitoxin of diphtheria affords no protection against tetanus. Each infection requires for its prevention or cure a specific antitoxin. Probably the only exception to this is in the case of snake-bite, for a serum can be obtained which is so highly antitoxic against the venom of one snake that it will counteract the poison of a snake of a different species.

The serum is usually injected into the anterior wall of the abdomen, but any part where the skin is loose will serve. It is better not to inject into the back or buttocks from the risk of bed-sores. The skin should be rendered aseptic by washing it first with soap and turpentine, and then with absolute alcohol or with dilute carbolic acid. When the bulk of the fluid exceeds 25 c.c., more than one injection will have to be made. Absorption soon takes place, and manipulation of the part is quite unnecessary. A special syringe must be employed, and it should take to pieces so that it may be readily boiled in a test-tube. The most convenient capacity is from 10 to 20 c.c. but the 25 c.c. is useful. There is no particular advantage in having the glass barrel or piston graduated. The platinum and iridium needles can be sterilised in a spirit flame. The syringes are supplied by most makers of serums, and cost about 12s. 6d.

Serum treatment is employed in diphtheria, in the pyogenic diseases, such as erysipelas and puerperal fever, in tetanus, glanders, anthrax, and snake-bite. There are indications that before long its scope of action will be extended to other diseases. The records of well-observed cases of necessity accumulate somewhat slowly, and it is necessary to rest on well-established ground before taking a new departure. There is reason to think that simple physiological serum may have some value as a curative agent, and of late horse serum has been employed tentatively. Horses are not prone to tubercle, and it is possible that ultimately advantage may be taken of this fact. Horse serum is supplied for test by several makers.

Antidiphtheritic Serum.—The most notable success of serum therapeutics is in connection with diphtheria. Introduced originally by Behring in 1890, and elaborated by Roux of Paris, it has been universally adopted. Aronson was the first to utilise horses in the preparation of the serum. Statistics have accumulated to an enormous extent, and without exception show a marked diminution in the mortality from the disease under the serum treatment.

There are many brands of antidiphtheritic serum, varying much in the number of units they contain. The serum is now always prescribed according to the number of units, irrespective of the dose of the injection. The antitoxin unit is the amount of antitoxin which, injected into a guinea-pig of 250 grammes in weight, neutralises 100 times the minimum fatal dose of toxin of standard strength. This is known as the Behring unit. The Ehrlich unit is somewhat different, the test dose being that which, when mixed with a unit of serum, just suffices to kill the animal in four days. Roux's constant is a toxic solution, of which 0·1 c.c. kills a guinea-pig weighing 500 grammes in twenty-four hours. These standards are arbitrary and conventional, but they are convenient. The mode of manufacture of these serums is, under expert guidance, being constantly improved, and in most cases the maker's guarantee as to strength, purity, and dose has to be accepted. Many of these products, however, are under some form of central control. In Germany all forms of serum permitted to be sold are subject to constant official examination. The bottles are filled under supervision, and to each is attached a lead seal, on which is stamped the number of immunising units. This plan is followed by one firm in England, every batch of antidiphtheritic serum being tested by the Superintendent of the Laboratories of the Royal College of Physicians of London and the Royal College of Surgeons of England, under whose supervision the bulbs are filled. It may be that the guarantee is not greater than that afforded by the experts attached to other firms, but it is an additional security.

The antidiphtheritic serums in common use in this country are those prepared by (1) The Jenner (formerly the British) Institute of Preventive Medicine, (2) Burroughs Wellcome and Co., (3) Parke, Davis and Co., (4) E. Merck (Darmstadt), (5) Behring (Fabrik: Hochst-Am-Main), (6) Aronson (Berlin: Schering's Fabrik), and (7) Roux (Institut Pasteur, Paris). The preparations used in the United States are those of: (1) The New York Board of Health, (2) Parke, Davis and Co., (3) Burroughs Wellcome and Co., (4) Mulford and Co. of Philadelphia, (5) Gibier of New York, (6) Behring, (7) Aronson, and (8) Roux.

Many of these preparations are sent out in several different forms.

The Jenner Institute (Chelsea Gardens, Grosvenor Road, London; agents, Allen and Hanbury) offers the serum in vials containing 2000 units, supplied in cases holding two vials, at 5s. the case. Burroughs Wellcome and Co. (Snow Hill Buildings, London, E.C.) supply their serum in hermetically sealed tubes containing (1) one prophylactic dose of 1000 units at 1s. 3d.; (2) one therapeutic dose of 2000 units at 2s. 6d.; and (3) one therapeutic dose of 4000 units in 5 c.c. or less at 7s. 6d. Parke, Davis and Co. (111 Queen Victoria St., London, E.C.) offer two grades of serum differing in their potency. For an early case No. 4 of the X or Standard, containing 2000 units at 3s. 2d. may suffice, but it would be better to use the XX or Special at 6s. 2d. For an advanced case two doses of No. 6 XX Special, containing 4000 units, would be necessary, and this costs 9s. 6d. a dose. For very severe cases two doses of No. 8 Special, containing 6000 units in each, at 15s. the dose, would be required. E. Merck of Darmstadt supplies "500-fold" serum in doses of 600, 1500, and 3000 units, and also sends out "1000-fold" serum. Behring's serum is comparatively little used in England, but in the United States the higher grades, Nos. 4, 5, 6, and 7, containing respectively 200, 300, 400, and 500 units in each c.c., are employed. Aronson's serum has ceased to be popular, whilst that of Roux is said to be no longer prepared under his personal supervision.

The more potent the serum and the greater the number of antitoxin units contained in a c.c. the better is it adapted for practical purposes. When from 8000 to 12,000 units have to be given, the bulk of the injection is a matter of considerable moment, especially in the case of children, who do not take to frequent or multiple injections kindly.

These serums, if kept in a cool place and away from the light, will remain active for a year, but there is always some decadency of potency, and the higher the grade the greater the deterioration. Some makers add an additional number of units to their phials to counteract this tendency. A phial once opened must be used immediately; the portion unused is useless.

Dried antidiphtheritic serum is sold by some makers, and the Jenner Institute supplies it in tubes containing 300 units, at 60s. the dozen tubes. It is said to be useful for export, but as the ordinary tubes bear carriage well there seems to be no particular advantage in its employment. In dissolving the scales from 2 to 3 c.c. of water, which has been boiled and allowed to cool, should be poured into each tube. Care must be taken by shaking and rotating the tube to prevent the scales from caking.

The question of dose is very important, and a good deal depends on the stage of the disease in which the patient is first seen. If the treatment is commenced on the first day 2000 units will suffice, but if delayed until the second day from 8000 to 12,000 units will be necessary. Putting it in another form, for a mild, that is an early case, in which the exudation is limited and there are no constitutional symptoms, 2000 units is the dose, whilst for more severe cases, those usually seen on the second day, from 8000 to 12,000 units will be required, the exact dose depending on the extent of the exudation and the gravity of the constitutional symptoms. The injection will have to be repeated within twenty-four, and probably within twelve hours, but if the patient show signs of decided improvement only one-half of the initial dose need be given. As a prophylactic 600 units will suffice. The serum treatment should invariably be resorted to in children, and practically in every case, the only possible exception being in very mild cases in adults. Time is of the utmost importance, and not a moment should be lost. On the first day a dose of 2000 units will secure a result which 50,000 will not effect on the third or fourth. It is useless to wait for the result of a bacteriological examination, for that involves loss of valuable time, and it is well known that there are many cases which are clinically diphtheria, but which bacteriologists decline to recognise as such. The serum has no toxic action, and it is better to give too much than too little. In severe cases the patient must be brought rapidly under the action of the drug. This is especially the case when there is broncho-pneumonia as a complication, for then the lungs always contain bacilli in large numbers.

Although the general consensus of opinion is in favour of large doses, Professor John H. Musser of Philadelphia claims that he has obtained good results from small and frequently repeated doses, especially in children. For children under eight he gives 500 units, repeated every six hours, whilst for children over eight he gives 1000 units, and repeats it at intervals of from six to eight hours.

Toxic effects sometimes follow the injection of the serum, but they are rarely of importance. They commonly assume the form of a rash, which may be urticarial or erythematous. Sometimes it is scarlatiniform, or it may be like the rash of measles. The urticaria may attack not only the skin but the mucous membranes, giving rise to vomiting and diarrhœa, and even urethritis. As there is usually some pain in the joints with elevation of temperature, there may be a difficulty in diagnosis. The antitoxin rash usually appears on the eighth day, is seldom seen before the sixth day, and rarely appears after the eighteenth. The occurrence of the rash bears no relation to the amount of antitoxin injected. The serum itself is not toxic, and these untoward symptoms are due to impurities. It is said that with some serums there is never any rash. In one instance in the United States a batch of antidiphtheritic serum in the process of manufacture became contaminated with tetanus bacillus with disastrous consequences.

The administration of the serum does not contraindicate the use of local measures, and every effort should be made by spraying, irrigation, and swabbing to remove exudation. The use of the serum will not prevent the occurrence of post-diphtheritic paralysis. There is no evidence that the serum produces nephritis.

Antistreptococcus Serum.—The first attempt to cure streptococcic infection by the use of serum was made by Marmoreck in 1895. The serum is now used in erysipelas, cellulitis, general suppurative peritonitis, suppurative disease of the middle ear, thrombosis of the lateral sinus, and puerperal septicæmia. In malignant endocarditis it sometimes answers well, but not uncommonly fails. The organism associated with this disease may be a streptococcus or it may be a staphylococcus. If the disease is due to streptococci the antistreptococcus serum proves efficacious, but if it is due to staphylococcal infection it is useless. The nature of the infection is usually difficult to determine, so that the results are uncertain. Marmoreck's claim that his serum will cure all streptococcic puerperal infections appears not to be substantiated. The serum is of great value in certain cases, but in others apparently identical it has been found useless. This is attributable to their causation by different varieties of streptococci. Should a particular serum fail, it would be well to try a serum from another source. It is now recognised that a serum obtained from a given streptococcus may protect an animal from that organism, but be absolutely inefficient against another streptococcus. It is clear that the number of serums which can be prepared is limited only by the varieties of streptococci which exist.

The results obtained in erysipelas and other streptococcal infections are often so strikingly successful that the serum should be used in every case, especially as its administration does not preclude local treatment or even the administration of drugs such as perchloride of iron by mouth. Antistreptococcic serum is supplied by the Jenner Institute; Parke, Davis and Co., and other makers, but whether their products are identical it is impossible to say. It is best to inject three doses of 10 c.c. at intervals of six hours, with of course the usual antiseptic precautions. The case containing the three 10 c.c. vials costs from 7s. 6d. to 12s. Burroughs Wellcome supplies both an antistreptococcus and an antistaphylococcus serum in 10 c.c. phials. These serums have no toxic action, and 30, 35, and even 75 c.c. have been given as a dose. In a severe case of erysipelas it would be justifiable to begin with 20 c.c. of the antistreptococcus serum.

Antitetanic Serum.—The treatment of tetanus by antitoxin was introduced by Behring and Kitasato in 1890. Tetanus was the disease in which investigation led to results which paved the way for the more important serum treatment of diphtheria. It was selected for the purpose of experimentation from the certainty with which definite results could be obtained in animals submitted to observation, and yet, strangely enough, of all the serums in common use the antitetanic gives the most unsatisfactory results. The antitetanic serum commonly employed is that of Tizzoni and Cattani. It is in the form of dry scales, and is supplied in vials containing 4½ grammes, or sufficient for an ordinary adult case, at 45s. the vial. The best plan is to inject 2·25 grammes at the first dose, and 0·6 grammes for subsequent doses. The scales may be dissolved in distilled water, normal saline solution or blood serum. The Jenner Institute supplies the serum in cases holding three tubes of 10 c.c. each, at 12s. the case. They also supply a dried serum in tubes containing 3 grammes, at 12s. a tube. Burroughs Wellcome and Co. supply the serum in phials containing 10 c.c. at 3s. 4d. each. The dose employed should be large, to the extent even of 100 c.c. of the serum, so that the treatment must of necessity be expensive. The direct strength of a tetanus toxin is measured by the body weight in grammes of an animal which is killed with certainty by 1 gramme of the toxin. The indirect strength of a toxin is its antitoxin neutralizing power. In some cases of tetanus in man very large doses have been given; for example, Wilms records the case of a patient who within thirty hours received 4,000,000 Tizzoni units, followed on the second, third, fourth, and fifth days by 1,000,000 units each day. There seems to be no particular advantage in intracranial injections.

The serum gives the best results in chronic cases. It not infrequently happens that the bacillus is localised and confined to the seat of infection, so that free excision with the application of pure carbolic acid should be resorted to in addition to the use of the antitoxin. Horses, as is well known, are especially liable to tetanus, and in them the antitetanic serum answers well. By systematic immunisation with the serum the death-rate amongst them from this disease has been materially reduced. A veterinary antitetanus serum is supplied by Parke, Davis and Co. at 4s. the oz.

The immunity to tetanus in man conferred by the serum is temporary, and is probably limited to six or eight weeks. The antitoxin is excreted by kidneys, mammary, and other glands.

Antivenene.—For our knowledge of the treatment of snake-bite by this substance we are indebted chiefly to the researches of Sir Thomas Fraser of Edinburgh, and Dr. A. Calmette of Lille. Venomous snakes may be divided into two categories:—(A) Poisonous colubrine snakes; (B) viperine snakes. In class (A) are included the cobras, the kraits, the coral snakes, the moccasins, the tiger snake, the black snake, and the deaf adder. In class (B) are the English viper, the rattlesnake, the *Daboiá Russellii* of India, and the *Echis carinata.* Although these poisons have different physiological actions the same antidote is used for all. The dose of serum required to protect a man against a lethal dose of the most deadly venom is from 10 to 20 c.c., but additional security would be afforded by injecting 30 or 40 c.c. No ill-effects attend the injection of the serum, which acts most surely and quickly when injected intravenously. The more speedily the injection is made the greater the patient's chance of recovery. There should be no relaxation in the mode of treatment ordinarily adopted, and ligatures and local treatment should be employed. Antivenene is now distributed largely in India, and specimens returned after a year showed no falling off in activity. The charge made by the Jenner Institute for 10 c.c. tubes is 50s. a dozen.

Coley's Fluid.—This fluid is named after Dr. William B. Coley of New York. It is a mixture of the streptococcus of erysipelas with *bacillus prodigiosus*, a non-pathogenic organism which is supposed to possess the property of intensifying the action of certain pathogenic germs. The two organisms are grown together in the same broth, the erysipelas streptococcus being first grown alone for ten days, when the other germ is added and the cultivation continued for another ten days. The cultures are heated to a temperature sufficient to render them sterile, and the fluid is then used without filtration. This preparation is much stronger in its action on malignant tumours than the filtered solution. The best plan is to begin with a small injection, ½ to 1 minim, and to gradually increase it daily until the reaction temperature reaches 103° or 104° F. The temperature is the best guide in estimating the dose, and very little benefit accrues in cases in which no reaction occurs. The frequency of the injections will depend on the general condition of the patient, and on the rapidity of recovery from the depression of the preceding dose. Usually the injections are administered daily, an endeavour being made to get two or three good reactions a week. The most virulent cultures give the best results. The treatment should be continued for three weeks, and if at the end of that time there is no improvement it should be abandoned. In some cases, however, it has been continued for three months, with from time to time an interval of a few days. The serum may be injected either subcutaneously, or into the substance of the tumour, but the former method is preferable. The usual precautions are taken in administering the injection, the skin is rendered aseptic, and the needle is sterilised by being passed through a spirit flame. The chief dangers are from collapse from too large a dose of the toxins being injected into a vascular growth, and from pyæmia, due to insufficient precautions as regards asepsis, especially in cases where there is a granulating or sloughing surface. With the observance of strict aseptic precautions, however, the risk is small.

The mixed toxins may be used in any form of malignant tumour which is clearly inoperable. It may also be employed after primary operation to prevent recurrence. The beneficial effect is slight in most cases of carcinoma, including epithelioma, and it is most marked in sarcoma, but varies with different types; the spindle-celled form being the most favourable for treatment.

Most of these statements are given on the authority of Coley's papers, and many of them require confirmation. Prof. Robert B. Wild of Manchester treated eight cases of inoperable cancer by this method. The patients were kept under observation until death, and in six of them the diagnosis was confirmed by autopsy. Dr. Wild thinks that in cases of inoperable carcinoma and epithelioma there is no evidence of permanent benefit, but that in the absence of other means of effectual treatment a trial of the serum is justified in cases of inoperable sarcoma, especially the more rapidly growing forms.

Coley's fluid is supplied by the Jenner Institute in tubes of 2 c.c. at 5s., and by Parke, Davis and Co. in ounce vials at 12s.

Mallein.—Glanders, farcy, or mallein, is a disease due to the presence of the *bacillus mallei*, a short, non-mobile bacillus, not unlike that of tubercle, but exhibiting different staining reactions. The toxins which are produced in cultures of this bacillus have been separated, and in concentration as a glycerine extract are known as mallein. It is used diagnostically in horses supposed to be suffering from glanders to detect the presence of the disease. When injected in a dose of 1 c.c. into a glandered horse, the temperature rises from 2° to 4°, whilst in a horse free from glanders no reaction is obtained even after a dose of 6 c.c. It is also employed for conferring immunity on horses, and for curing them of the developed disease. Mallein is of little use in the acute farcy of man, which is an almost uniformly fatal disease, but in chronic cases it is useful. The continued injection of $\frac{1}{20}$ to $\frac{1}{15}$ c.c. at intervals of two days is usually followed by improvement. Mallein can hardly be regarded as a commercial article, but it is supplied by Parke, Davis and Co. at 2s. 6d. the c.c., the dose required for diagnostic purposes in horses.

Tuberculin.—Whether in an article on serum therapeutics this substance should be included is open to question. Koch's original tuberculin is now very rarely used therapeutically. For diagnostic purposes both in man and in cattle it answers admirably. A patient may be suffering from tuberculous peritonitis, and yet the symptoms and physical signs may be so obscure as to leave the diagnosis in doubt. A bottle of the original tuberculin is procured, and 1 c.c. is diluted with 9 c.c. of 0·5 per cent phenol to make a 10 per cent solution; of this 1 c.c. is diluted with 9 c.c. of the phenol to make a 1 per cent solution. Of this dilution 10 minims are administered subcutaneously with the usual precautions. If the patient is not tuberculous there is no rise in temperature, but if tubercle is present it will run up to 102° or 103°, and fall again in twenty-four hours. There will probably be considerable constitutional disturbance indicated by restlessness, headache, pains in the joints, and inability to sleep.

The preparation commonly employed in the treatment of phthisis is tuberculin R. The best plan is to begin with a dose of $\frac{1}{500}$ mg., and to run up to 20 mg. The larger doses are expensive,—about 17s. a dose,—and from 50 to 60 injections may be required, although not all of this magnitude. Good results have sometimes been obtained, but usually in conjunction with favourable hygienic conditions, and the administration of cod-liver oil and other remedies. It appears to be of very little use in mixed infections or in advanced cases. In a few cases carefully observed at the Westminster Hospital it did no good, and its use had to be abandoned. It produces a very slight reaction even in moderately large doses. Tuberculin, as a diagnostic agent, is invaluable, but therapeutically it leaves much to be desired.

Maraglioni's serum is frequently spoken of in connection with the treatment of tuberculosis, but it is difficult to obtain definite information respecting its action. Campana of Rome states that it is nothing but Koch's tuberculin improved. Rumpf of Hamburg maintains that it has no therapeutical effect, whilst Bertola says that it has a specific action in tuberculosis, but that it must be administered for a long time. It has been but little used in England.

Antienteric Serum.—This can hardly be regarded as a therapeutic agent although it is a powerful prophylactic. The results obtained by the inoculation of the serum in the case of the officers and men of the military garrison during the siege of Ladysmith, as published by Prof. A. E. Wright of Netley, are distinctly encouraging, inasmuch as they show that the proportion, on the one hand of attacks and on the other of deaths, was seven times less in the inoculated than in the uninoculated. If the number of men, no doubt a considerable one, who had previously suffered from enteric had been subtracted from the number of the uninoculated, the statistics would have borne an even more favourable aspect.

Antipneumococcic Serum.—Several serums of this description have been prepared by Pio-Foa, Washbourn, and others, but they are rarely used.

Health Resorts.

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This article is confined strictly to the consideration of resorts which depend on climate only, and not on the effect of mineral water, whether internal or external. Owing to the limitation of space the subject can only be dealt with very briefly; and it is impossible to do more than mention some of the most important. Descriptions of individual resorts must be sought for in more extensive works, of which a bibliography is given at the end of the article. New resorts are being opened out every year as the range of travel increases; and it becomes constantly more difficult to keep up with every fresh locality. The plan adopted in this article has been simply to take the most important and best known resorts in each country and indicate briefly for what diseases they are best suited. The general conditions of climatic treatment are briefly dealt with at the beginning of the article.

Classification of Climates

The simplest classification of climates is into (1) Marine climates, which admit of no subdivision, and (2) Inland climates, which are divided into high altitudes and low altitudes, the desert being a special sub-variety.

Marine climates may be partially differentiated into coast and island climates. Of course in the case of small islands the whole climate is practically marine, though a very small amount of elevation above the sea-level makes a very considerable difference in the effect of the climate on some people who are sensitive to the influence of the sea. Examples of marine climates are the Riviera, Madeira, and Bournemouth; they are characterised by greater equability of temperature, greater warmth in winter and coolness in summer, owing to the presence of the sea, which delays radiation, also greater humidity and usually a larger amount of sunshine. In a country like England, where fog and mist are very prevalent inland during the autumn months, the amount of sunshine enjoyed on a greater part of the coast is very considerably more than in inland places, as the sea fogs are comparatively infrequent.

As to their effects on the organism, they vary considerably; some, *e.g.* the resorts on the east coast of England and the eastern portion of the south coast, are very bracing, those in the far west and such places as Madeira are distinctly relaxing, whilst others are intermediate; much depends on the exposure, the prevailing winds, and the soil.

If we compare the effects of the marine resorts with those experienced inland, and especially at high altitudes, a great difference is observable, but hardly greater than may be observed between a very bracing and an enervating marine resort.

Perhaps the greatest difference is noticeable in the effect on the central nervous system, which in the case of high altitudes is much stimulated, whilst the sea almost invariably exercises a soothing influence. So great is the stimulation at elevations of 5000 feet and over that very unpleasant nervous tension is frequently produced by prolonged residence, and insomnia is a very common result. On the other hand, in a great majority of cases insomnia is benefited by a visit to the seaside.

In both cases metabolism is increased and appetite improved, but the so-called "biliousness," accompanied by constipation, of which many people complain on the coast, does not appear in mountain resorts. The way in which metabolism is influenced must therefore certainly differ in the two cases, but we have at present no physiological explanation to offer.

Increased activity of mind and body is a very marked feature of such climates as the Engadine and Colorado, and the sense of bodily fatigue is greatly diminished, which in itself is a danger to phthisical patients, as they thereby fail to notice the point at which they should check themselves..

Some things, such as the increased rapidity of pulse and respiration, are naturally accounted for on physiological grounds by the diminished supply of oxygen, but there are other factors, such as the electrical conditions, the effects of which are little understood. No one who has resided at high altitudes can have failed to notice the peculiar condition of nervous irritability which affects both man and beast during the prevalence of certain atmospheric states, somewhat similar to that which affects some people during a thunderstorm, but much more marked.

We have yet much to learn as to the physiological effects of high altitudes and diminished atmospheric pressure, and observers are by no means agreed in the results which have been obtained. Paul Bert, Egger, and others maintained that one of the first results was a notable increase in the number of red blood corpuscles, which they attributed to the deficiency of oxygen causing a greater need of oxygen carriers; but considerable doubt has been cast on these results, though the latest observations tend to confirm their truth.

Besides the diminished pressure and increased rarefaction of the air, there are several other points of importance in the atmospheric conditions at high altitudes.

(1) There is much greater transparency and diathermancy owing to the low degree of absolute humidity.

(2) There is greater difference between the sun and shade temperature, and the daily range of temperature is greater.

(3) The absolute humidity of the air is much lower owing to the lower temperature.

(4) The air is purer, being freer as a rule from inorganic dust and from micro-organisms, though not more so than true ocean air.

It is the presence of these qualities which makes the high climates so valuable in the treatment of phthisis and gives it its peculiarly stimulating qualities; and in addition there is an amount of electricity in the atmosphere of regions such as Colorado, the effect of which it is difficult to estimate, but which certainly has a remarkable effect on the nervous system.

The desert climate has something of the same effect as that of high altitudes, and the air is remarkably pure owing to its coming from a large and practically untainted area. The effects on the nervous system are much less in degree, but some people find it very stimulating, and it is not rare to meet with those who suffer from insomnia in Egypt, when living in or close to the desert.

CLIMATE AND ITS EFFECTS

Change of climate has become one of the most ordinary therapeutic measures in these days; to an infinitely greater degree since the expenses of travel have so much diminished, and the facilities so enormously increased. For one person who was sent abroad fifty years ago, probably fifty are sent now, and the increase has been very great in the last twenty years especially. The advantages of change of climate are fairly obvious, and have probably come within the personal experience of most men at some time or other.

We may look at the matter from either the physical or the mental point of view. (So far as the physical side goes, we are concerned here with climatic effects only, the question of baths being dealt with in another article (*v.* Balneology)). But, as a matter of fact, it is almost impossible to separate the results of the two factors. On the one hand, we may see a physical condition markedly improved when the sufferer is removed from domestic and business worries; on the other hand, mental depression may disappear like mist with the sense of physical well-being which a bracing climate produces. "Caelum non animum mutant qui trans mare currunt" is one of those proverbial generalisations which, after all, have only a limited application. Much, very much, depends on the constitution of the individual—much on the nature and causation of his ailment. It may be perfectly true that for the melancholic, the confirmed neurasthenic, the early general paralytic, for the man who has failed in life, has sustained crushing personal misfortune, or committed a hidden crime, mere change of climate may be useless or worse than useless, but, after all, such cases are the exception. There remain an immense number, the over-worked, the over-anxious, the bored, the hypochondriacal, for whom a judicious shifting of scene may form a fresh starting-point, and it is precisely the organisations which are liable to these troubles, because they are somewhat unevenly balanced, which are also specially susceptible to the effects of climatic change. Personal susceptibility to changes of weather and climate varies indefinitely, and is generally inversely related to the mental and physical robustness of the individual. The tireless worker will, as a rule, be found to be one whom no vicissitudes of weather materially affect.

Meteorology as a science is not to be dealt with here, but we may ask, What do we mean by climate, and what are the conditions that determine it? before going on to the consideration of actual health resorts. As a matter of fact we very rarely talk of climate except in relation to life of some kind, and we really mean by it the sum-total of the physico-chemical conditions, permanent or changing, in any given locality which affect life, whether it be animal or vegetable.

The determining conditions of climate in a place may be summed up as follows:—

(1) Latitude.
(2) Altitude.
(3) Orientation.
(4) Relation to sea, whether the centre of a continent, island, etc.
(5) Relation to mountain ranges (which is a question quite apart from that of altitude), forest, river, lakes, etc.
(6) Geological conditions of soil.

From these conditions result the various factors of climate, temperature, rainfall, winds, cloud, atmosphere, sunshine, humidity, electrical phenomena, the observation of which is the function of meteorology. But if we ask ourselves whether, in the present state of our knowledge, given all the data, we can predict the climate of a locality, and further, what its effect is on human beings, our answer must be a very guarded one.

There are subtle differences in the climate of places, often of places in close proximity to one another, which depend on factors of which we know nothing, yet the effects may be very obvious, not only on human beings but on plants and animals. The conditions are so complicated that it is impossible to disentangle the various influences at work, and we are really dependent in the last resort on empirical evidence. This being so, we may ask how far we can lay down any rules for the effects of climate on disease. Here again we cannot return a very definite answer; there are only a few facts which are well assured, and the rational basis of which is not far to seek. It is quite certain that high inland resorts, where the oxygen is deficient, the skin dry, evaporation rapid and perspiration suppressed, are bad for sufferers from renal disease; they are bad also for many cases of cardiac valvular disease, though by no means all. Further, it is obvious that chronic bronchitics and persons with a sensitive mucous membrane will do best in a warm equable climate, with little wind, and a moderate amount of moisture.

When we get beyond a few elementary generalisations of this kind we are completely at a loss, so far as scientific reasoning goes. It might be supposed that the drier the climate the better it would be suited for rheumatism in its various forms, but this is by no means the case; in many cases the symptoms are distinctly worse, probably owing to the rapidity of evaporation from heated surfaces in high dry climates.

Again, who is prepared to say what is the ideal climate for phthisis, when so much depends on the character or stage of the disease, and so much on the idiosyncrasies of the individual. It matters not what health resort you visit, whether by the sea or in the mountains, you will find a large number of phthisical patients who attribute their recovery to the place, and are confident that they would not have got the same benefit elsewhere. This goes a long way to prove what is now strenuously contended for, that any healthy locality where there is abundance of fresh air is suitable for the treatment of phthisis, whether it be high or low; but the writer has a strong opinion that to obtain the best results each individual must find the climate that suits him best. The vast majority of people feel better in one climate than another, and know very well where they are at their best. There is an "optimum" climate for the individual, just as there is an "optimum" temperature for different bacilli, and provided that that climate is not definitely contraindicated by the physical condition, each individual will do best in the climate he likes best. The present writer cannot agree with those who hold that difference of climate makes no difference, *e.g.* in the rate of healing of tubercular lesions, other conditions being equal; but this is a point which it is almost impossible either to prove or disprove. The upshot of this is that that medical man will act wisely and probably do the best for his patient, who within certain wide limits consults the patient's own likes and dislikes, and does not on *a priori* grounds commit him to Colorado or Madeira. In some cases, of course, it is impossible to be too emphatic as to the inadvisability of certain climates, but much *a priori* reasoning on the subject is falsified by experience. It might be supposed, for example, that altitude and diminished pressure would be bad for aneurisms, but this is absolutely not the case, unless there be valvular disease or extensive aortic degeneration associated with it.

There is a climate which has many of the advantages of the high altitudes, viz. the bracing effects and purity of air and dryness without the disadvantages of diminished pressure and cold; that is the climate of the desert, best obtained in Egypt or inland Algeria. We shall return to this later in dealing with separate health resorts.

This part of the subject will best be closed by a word of warning as to journeys which are not infrequently fatal to invalids before they have arrived at their destination. Personal experience has convinced the writer that many invalids, and especially those who have not the means to travel in luxury, would have a far better chance of recovery if they remained at home, with home interests and home comforts. This applies particularly to those whose bodies are very dependent on their mental conditions, and who stand a good chance of finding themselves stranded in a strange country with no friends and no occupation, and with nothing to dwell on but their own physical condition. This point is often unconsidered when the question arises of sending people abroad, yet it is one of the greatest importance, especially in the case of phthisical patients, many of whom belong to that type of mankind in whom the mental factor is very predominant. In the choice of a health resort for an individual case we have, therefore, first to consider whether the bodily condition is such as imperatively to demand a certain climate or debar others, *e.g.* whether the presence of renal disease makes warmth absolutely indispensable. It is assumed that the patient is in a fit condition to travel, though, as we have already said, it is far from being the case with all patients sent abroad. We then have to consider what range of places is open for choice, and to select that one which seems best suited to his physical and mental condition, and to his purse. The latter is an important point, as it is better for many if not most to live in comfort in a place which may not be the absolute best, rather than have bad rooms and bad food in some spot which might perhaps suit them rather better from a climatic point of view.

Finally, we shall do well to impress on patients that they should study the peculiarities of the climates to which they are going, and on their first advent seek the advice of some competent physician practising in the place.

Reasons for sending Patients Abroad

When we come to consider the reason for which patients are sent abroad, and the diseases which are the cause of their seeking advice, we find, as a matter of fact, that an overwhelming proportion of those who are definitely ill, go on account of some tuberculous trouble. This is, of course, exclusive of the very large class who go for hydropathic treatment, whether external or internal, with whom we have nothing to do. Of those who go abroad during the winter, a large majority will be found to have had some signs of pulmonary or other tuberculous disease, probably far more than appears at first sight, the original cause being lost sight of in a good many instances or cloaked under some such term as bronchitis. Besides these, there are, of course, a great many cases of genuine bronchitis or emphysema, sufferers from which find themselves much freer from their trouble in a milder and drier winter climate. Further, there are a certain number of patients with chronic renal disease, diabetes, or cardiac trouble, to whom warmth is of the greatest importance, and who prolong their lives materially by avoiding the cold of an English winter.

There is also a large class of sufferers from rheumatism in its various forms, who find relief, if not cure, in more southerly latitudes, and are at all events able to be out and about a good deal more than they would be at home.

Lastly, there are the aged, the worn-out and over-worked, the weaklings, the people with poor physique, feeble circulation, and defective development generally, the hypochondriacs and neurasthenics, who, if they do not expect complete recovery, prefer to minimise the evil of existence by basking, so far as they can, in warmth and sunshine.

If we turn now to the climates which are regarded as useful for these various ailments, we notice first that, as has already been said, almost every kind of climate has been recommended for tuberculosis, from that of the high mountains to Madeira, but the high, dry, cold climates, such as the Engadine, Colorado, or South Africa, are pre-eminently suited for pulmonary phthisis, though unsuitable in many other morbid conditions. On the other hand, the warm climates, whilst they may be beneficial to phthisis according to their bracing qualities and the degree of humidity, are also valuable in numerous other cases. Such climates are those of Egypt and the African desert, the moderate elevation (2000-3000 ft.) of the Australian plateau, parts of New Zealand, and in a less degree the Riviera. If analysed on a meteorological basis they are very different, and very different in their effects, but they constitute a large intermediate class of climate with very diverse applications, including the treatment of tuberculous conditions. There remains a class of warm, moist climates, such as Madeira, the West Indies, and other tropical or semi-tropical places, which are definitely unsuited for most cases of phthisis or tubercular disease, and are chiefly valuable for the aged, the feeble, and people with irritable mucous membranes, who are not susceptible to the depressing influences of moist, relaxing air.

Thus classified in relation to tuberculosis, which is after all the main test, we have three varieties of climate, viz. that of high altitudes, suited to the consumptive; a very large intermediate class, with variable characteristics, but bracing, moderately warm, and at least fairly dry; and the third class, which is for the most part unsuited to phthisical patients, though beneficial in other pulmonary conditions. It is to the large intermediate class that sufferers from the other ailments, which climate benefits, for the most part resort.

English Health Resorts

Taking the marine resorts first, we may begin with the south coast. We may begin at the east, and if we except Dover, which is not much frequented by invalids, we come first to Folkestone, one of the most popular places on the coast, with a distinctly bracing climate on the high ground and a rather milder one in the lower parts of the town.

Near by are Sandgate and Hythe, which are quieter and less bracing.

Hastings and St. Leonards have a comparatively mild climate, and are mostly frequented in winter, but are not so well suited for the really delicate as the south-western resorts and the Isle of Wight, and, like all the resorts of this section of the coast from Folkestone to Worthing, are cold in the spring months.

Bexhill, further west, is a growing place, with a very bracing climate.

Eastbourne is chiefly a summer and autumn resort. It is sheltered from the south-west by Beachy Head, but fully exposed to the east, and therefore cold in the spring.

Seaford is a quiet but growing place to the east of Beachy Head, and therefore sheltered from the east winds to some extent.

Brighton has a very bracing climate, and though not facing so much east as Eastbourne, a large amount of east wind in the spring. The autumn and early winter months are often delightful, and, like most of the towns on this part of the coast, it enjoys a larger amount of winter sunshine than almost any part of England, except Torquay and Falmouth; about 450 hours yearly more than London. The chief season is autumn and early winter, but it is largely frequented at most seasons owing to the easy access from London.

Worthing, though near by, has a milder climate, and is noted for its fig gardens.

Passing by Bognor and Littlehampton, both quiet little places with good sands, we come to the Isle of Wight, where Ventnor, on the under cliff of the southern shore, shares with Bournemouth the reputation of being the best resort for consumptive patients in England. The climate is much milder than any of the mainland resorts, except the Cornish, yet not relaxing, and the place is well sheltered by the downs behind.

Bournemouth, though less sheltered, is favoured by a dry sandy soil and extensive pine woods; the climate is more bracing than that of Ventnor.

Weymouth has a fairly bracing climate and fine sands.

Sidmouth, near the mouth of the Exe, is remarkably sheltered, and has a large amount of winter sunshine.

Torquay has a reputation for pulmonary cases second only to Ventnor and Bournemouth, but is much more relaxing, warmer, and moister; less so, however, than Falmouth, which is well suited for bronchitic patients, and especially for those who have spent their lives in tropical or semi-tropical climates. It has a higher temperature and less daily range than any place in England, except the still more westerly Penzance and its neighbourhood, but is more sheltered than the latter.

On the north coast of Cornwall are St. Ives, Newquay, and Bude, all more bracing than the southern resorts.

Ilfracombe is the principal health resort of the North Devon coast. It is somewhat exposed, but has a mild winter climate.

Clevedon and Weston-super-Mare have long had a reputation in the west of England; the latter is the more bracing, and is specially beneficial to children.

In Wales, Tenby, Aberystwith, and Barmouth are the best known resorts in the south, and in the north Llandudno, Colwyn Bay, and Rhyl, which are much frequented by the inhabitants of Manchester and Liverpool.

Inland resorts in England, apart from those places which have baths and mineral waters, are very few in number—in fact Malvern is almost the only one of note. Great Malvern has an elevation of 520 feet, and an equable but fairly bracing climate. It is largely visited by invalids of all descriptions and those who need recuperation after hard work or illness.

Ilkley in Yorkshire is a similar recruiting place for the inhabitants of the large Yorkshire towns, but is practically only a summer resort.

Some of the spas, such as Harrogate and Buxton, may be visited for their climates as well as their waters, but have only a summer season.

More inland resorts are greatly to be desired in England, as at present the health resorts are almost confined to the coast; but in the English climate it is difficult to find inland places which would be suitable all the year round.

Two which should be mentioned, though the accommodation for visitors is scanty, are Hindhead in Surrey, at an elevation of 800 feet, and Crowborough in Sussex, which is a little more. The elevation for the south of

England is very considerable, and both possess bracing climates. There is a good hotel in each place, but otherwise house room is rather difficult to get, most of the houses being in private hands and likely to remain so.

SCOTCH HEALTH RESORTS

The well-known places on the west coast are more to be regarded as summer pleasure resorts than as health resorts, and are for the most part too humid for invalids; the best known of them are Wemyss Bay, Helensburgh, Rothesay, and Oban.

On the east coast, which is drier and more bracing, but very cold during the spring months, when winds from the east and north-east are prevalent, there are several resorts of considerable value, of which Nairn, Strathpeffer (apart from its baths), Portobello, and North Berwick are the best known.

During the summer, autumn, and early winter, the climate presents considerable advantages over most parts of the British Isles, the air being dry and invigorating and well suited for early phthisical cases and those which need bracing.

These are all seaside places, and many more could be named on the same coast. Of inland resorts Pitlochry in the Perthshire Highlands, but at no very great elevation, and Braemar are the two best known. The latter at an elevation of 1100 feet comes nearer to being a mountain resort than anything else in Great Britain, and has a most delightful and invigorating climate. It is crowded during July and August, but is said to be delightful during May and June and in the antumn, though of course rather cold. Those who cannot go to Switzerland will get many of its benefits here and find excellent accommodation.

IRELAND

Ireland, whilst affording many spots much frequented by sportsmen and tourists, cannot be said to possess any well-known health resorts. It is for the most part too damp and uncertain a climate for invalids, and in all except a very few places the accommodation is limited and apt to be rather rough.

FOREIGN AND COLONIAL HEALTH RESORTS

Space will not admit of more than a very brief notice of the main health resorts outside the British Isles, and only those will be mentioned which are frequented by English visitors.

In Europe the principal are—(1) the highlands of Switzerland, *i.e.* the Engadine, Davos Platz, Arosa, and a few in Germany and Austria; (2) the Riviera, Italian lakes, and Mediterranean resorts, such as Algiers, Tangier, Malta, and finally, Egypt, which geographically is better classed with Europe than with Africa; the only other health resorts of that continent being in the extreme south.

Outside Europe and the Mediterranean there are not a great number of places visited by English people habitually, but there are many districts to which they frequently emigrate in the hopes of settling or finding employment in a good climate. The most important of these are South Africa, and especially the highlands of the interior of Cape Colony and the Orange River Colony; the great plateau of the North American continent, particularly Colorado, and the coastal state of California; certain districts of Australia, such as the Riverina and the Darling Downs; a good part of

New Zealand (with the exception of the extreme north and south), and the islands off the north-west coast of Africa: Madeira and the Canaries.

The West Indies are hardly a health resort, though a good many people now go out there in the winter partly for the sake of the voyage.

SWITZERLAND

It will be best to begin with those nearest home, and we may therefore take first the high altitude resorts of Switzerland, of which Davos Platz is the oldest and perhaps, on the whole, the most frequented.

It is situated in the Canton Grisons, about 5000 feet above the sea, and well sheltered from the winds, so that the air is particularly still. It enjoys some 1800 hours of sunshine during the year, or rather more than any place in England, and the climate is especially delightful in winter, when clear, bright, still days are the rule. It can now be reached by rail from Zandquart and Coire.

Arosa in a neighbouring valley, and St. Moritz in the Upper Engadine are resorts of a similar character, but about 1000 feet higher. The latter is not so well suited for the more delicate consumptives, as it is less sheltered and windier than Davos or Arosa.

Les Avants, above Montreux, on the Lake of Geneva, about 3500 feet, has less snow than Davos, and is suitable for cases which require less elevation.

Less known and more modern resorts are Leysin, near Aigle in Canton de Vaud, and Montana, above Sierre, in the Rhone valley—the former at an elevation of 4700, and the latter of 5000 feet. All these resorts are open summer and winter, the worst time being the late spring, when the snow is melting, and great care has to be taken to avoid chill. Davos may be said to be exclusively for consumptives, but St. Moritz is frequented largely even in winter by those who merely want a bracing climate and the enjoyment of winter sports, such as tobogganing and skating.

The remaining very numerous resorts of Switzerland, including such well-known places as Zermatt, Belalp, Grindelwald, Mürren, Pontresina, and the Maloja, are all summer places, and are chiefly frequented by holiday-makers and climbers. Grindelwald is now open in winter, but is not suited for invalids.

Of the lower resorts, which are much frequented by visitors in autumn and spring, and invalids on their way to or from the higher places, the best known is Montreux, on the Lake of Geneva, at an elevation of 1200 feet, but there are many others too numerous to mention.

ITALIAN LAKES

There are numerous places on the Italian lakes which are visited extensively by English people, but few of them are much frequented by invalids. Of these Locarno and Lugano, on the Lago Maggiore and Lago di Lugano respectively, are among the best known; they are both in Switzerland, though belonging to the Italian lake district, and both are used by invalids as temporary resting-places in the spring and autumn. In fact, most of the places in the lakes, such as Varese, Cadenabbia, on Lake Como, and Gardone Riviera, on Lago di Garda, are of the same character and only have a comparatively short season.

The same applies for the most part to the resorts of Southern Italy, such as Castellamare, close to Naples, Sorrento, on the Bay of Naples, Capri, and Amalfi. A few invalids go there to winter, but the majority are birds of passage.

In Sicily, with the exception of Palermo, which is a good deal frequented by pulmonary sufferers, the accommodation is not sufficiently good for invalids, and is rough even for ordinary visitors.

There are good hotels at Sorrento and Amalfi, and, of course, in Naples, but Naples is not to be recommended for invalids. A good many sufferers from chronic or stationary pulmonary disease may pass the winter very well in these southern Italian resorts, but they must not overrate the warmth they are likely to experience there any more than on the Riviera. In exceptional winters snow may fall even at Palermo, though rarely.

The few resorts on the Italian Riviera will be dealt with in conjunction with the French Riviera.

THE RIVIERA

For about fifty years the Riviera has been one of the favourite resorts of English people; and for a long time, when travel was much more restricted than it is now, and much more the monoply of the wealthy and luxurious, the Riviera was the fashionable wintering-place of the English upper classes, its only rival being Madeira, which was exclusively frequented by consumptives, often of an advanced type. The latter also went to Mentone in large numbers. Since the high Alpine resorts have come into fashion Madeira has been discredited, and rightly, and Mentone rather strives to exclude consumptives, who are not received at many of the hotels.

From its proximity to this country the Riviera must always remain a favourite resort with English people, as there is no other place within easy reach where sunshine and comparative warmth in winter are so easily to be obtained, or where accommodation so good and often luxurious can be got by those willing and able to pay for it. The Riviera stretches from Toulon to Genoa, and what is often called the Italian Riviera, from Genoa almost to Spezzia; it consists of a belt of land which varies in width from one to four miles, extending from the sea to the foot-hills of the Maritime Alps. The mountains, rising behind to a height of 3000 feet more or less, form a protection from the north, and, according to the locality, also from the north-east, north-west. The neighbourhood of the Mediterranean, with its large mass of water at a comparatively high temperature, together with the backing of mountains, is the cause of the mild climate as compared with other places in the same latitude.

The season for the Riviera is from November to May, though not many visitors arrive before the middle of November, and few stay on after the end of April. The intervening months are very empty, and most of the hotels are closed. It is a great mistake for invalids to leave the Riviera too early, particularly if they return straight to England, while the weather is still cold and the journey may be a serious risk. Speaking generally, they should not leave at the earliest before the middle of April. With regard to accommodation, there is a wide choice and no lack of comfort, but it is most important that invalids should have their bed and sitting-rooms facing south, as otherwise much of the benefit of the climate will be lost. French and Italian houses are also much more difficult to keep warm than English ones, the only means of heating being an inadequate wood fire.

Many people who winter on the Riviera for the first time make a great mistake in not providing themselves with suitable clothing. They expect only warm weather and do not bring the thick clothes required for an ordinary English winter, which are often equally necessary out there, although after the beginning of March thinner things are generally needed. It is always desirable for invalids to carry an extra wrap, as the changes of temperature in going out of the sun down a shady street are often great, and a severe chill may be incurred. Care should also be taken not to be out after sun-down, as, whatever the truth may be as to the fall of temperature at that time, an invalid may suffer severely from neglecting this precaution. There can be no doubt that the Riviera has in these respects a somewhat treacherous climate, besides the further drawback of very cold north-east and north-west winds in the spring. Speaking generally, however, its temperature is 10° F. higher than that of London during the winter months, the rainfall is much less, fog is almost unknown, and snow falls very rarely. The most rainy months are September and October and sometimes March. Looking to these facts, the Riviera climate may be described as dry, warm, and bright when compared with other districts in the same latitude, also stimulating; its drawbacks are the high winds just mentioned, the difference between its sun and shade temperatures, and the chill at sunset. Also to some people it is found, owing to this stimulating quality, to be very depressing, and those suffering from insomnia or nervous irritability may find their condition aggravated by residence on the coast.

Among the individual health resorts the most sheltered are San Remo and Mentone, which have less of this exciting quality, while Cannes on the whole has it the most. Nice is no longer so much of a health resort as a social centre, both on account of the amusements to be found in the town itself, and also because of its proximity to Monte Carlo. Nice is in fact the chief town on the Riviera, and has the advantages and disadvantages of its position, the latter weighing most with those who are in search of health, and for whom too many social distractions are not to be recommended; the suburbs of Mont Boron and Cimiez are much better in this respect for invalids than the town itself. A beautiful resort in the mountains, about eleven miles from Cannes, is Grasse, a town which has many advantages for those who find the sea coast unsuitable. It has a bracing climate and is fairly well sheltered, but the hotel accommodation is unfortunately rather limited. For quiet people who do not care for social distractions Hyères, with its suburb Costabelle, has many attractions; it is also one of the oldest of the health resorts on the Riviera. St. Raphael, midway between Hyères and Cannes, and Valescur have been recently much sought after by English visitors; those who wish for absolute quiet and repose will find the latter unequalled, with lovely scenery and beautiful walking excursions on the slopes of the Esterelles. Smaller places, all with good hotels but with no other accommodation, are Antibes, Villefranche, and Beaulieu on the French side, and Alassio on the Italian coast. Bordighera is rather larger and has many attractions; it is more bracing but also more exposed than San Remo. The Riviera di Levante, which stretches from Genoa to Pisa, is not so well suited to invalids, though very picturesque. Nervi, Rapallo, Santa Margherita, and Spezzia are, however, all frequented by invalids, or at least visitors whose object in travelling is chiefly their health, but the accommodation is not first-class, except at Nervi, and the climate is moister and less sheltered.

OTHER MEDITERRANEAN RESORTS

After the Riviera there are a considerable number of health resorts situated on the Mediterranean, of which those in Southern Italy and Sicily have already been briefly mentioned.

Valencia, Barcelona, and Malaga on the Spanish coast have all been recommended, particularly the latter, which has a specially mild climate, approximating to those on the southern shores of the Mediterranean; in none of these towns, however, is there as yet any real provision made for invalids.

Algiers has of late years been largely visited by English people, and in winter usually has a considerable English colony; it has a warm but very uncertain climate, a considerable quantity of rain falling in winter, and occasionally even snow.

Biskra, two days' journey inland from Algiers (one from Constantine), is on the edge of the Sahara, at a height of 360 feet, and is much drier than Algiers, but, like most places near the desert, it is liable to very violent winds, which confine invalids to the house sometimes for several days consecutively.

Tangiers, which is situated in Morocco, between the Atlantic and Mediterranean, has a warm but moist climate, owing to the Atlantic storms touching it. Its civilisation has hardly reached the point at which it can be considered a health resort.

Besides Sicily, some of the smaller islands of the Mediterranean deserve to be considered. Not a few English go to *Malta*, largely owing to its being a garrison town, but it is too windy and devoid of shelter to be considered as a suitable place for invalids.

Ajaccio, in Corsica, is a very attractive place, but the sea voyage from Marseilles in poor steamers is a great bar to many travellers. It is warmer and moister than the Riviera, with a large number of bright sunny days. The climate is more sedative than that of the Riviera, and therefore suits some invalids better. Those who go there must make their own amusements.

EGYPT

Turning to the eastern end of the Mediterranean we come to Egypt, which has since the English occupation become one of the most important places for English invalids, displacing the Riviera to a considerable extent.

Alexandria, on the north coast, has no pretensions to be a health resort and is a very unattractive town.

Cairo, too, is quite unsuitable for the serious invalid and should be regarded merely as a halting-place. The town itself is unsanitary, though the hotels are good, and the amount of social life which goes on in winter is far too strong a temptation for invalids.

Mena House, eight miles from Cairo, on the edge of the desert, close to the Pyramids, and Helouan, about fifteen miles distant on an oasis, both have excellent hotels and every accommodation for invalids. The latter is more suitable in the early winter owing to its being raised above the inundated delta; it is therefore much drier during November and December than Mena House. Luxor, on the Nile, 450 miles south of Cairo, has a milder climate and less wind; it is delightful from December to the end of February. It has the drawback of an Arab village, and a large area of irrigated land in the immediate vicinity of the hotel, and more suitable sites could be found in the desert at no great distance. Assouan is at the first cataract and practically on the desert, hence it is drier than Luxor, though both are rainless, rain being unknown in Upper Egypt. It is owing to the same cause probably more bracing than Luxor, though distinctly warmer; uncomfortably so after the beginning of March. What effect, if any, the new barrage will have on the climate of Assouan remains to be seen. The question of the journey up the Nile is one of no little importance; the steamers are distinctly dangerous for invalids, especially in returning against the strong north wind, while dahabiehs are costly and slow. Moreover, unless a physician be taken, the invalid on a dahabieh may be far removed from medical aid in the time of need. The question will probably soon be solved by the extension of the train service as far as Assouan, but the river will always retain very great attractions for those whose sole care should be their health. Besides the danger of chill on the river itself, the risks are considerably increased by the temptation to visit numerous places of interest on the voyage; few of them without their dangers for invalids. In truth this constitutes one of the great drawbacks of Egypt, for the contrast between sun and shade temperature is very great, and fatigue under the hot sun followed by chill may have disastrous consequences. If the question has not been settled before arrival, an invalid had best take advice in Cairo as to the most suitable means of going up the river.

Egypt owes its reputation chiefly to the desert, of which it is largely composed, and the real problem for the invalid is to make the most of the desert air. The air is extraordinarily pure and very bracing; the rainfall south of Cairo almost nil, and the number of bright, warm, sunny days very great. On the other hand, the winds are often very cold, especially the north wind, which is prevalent during a large part of the winter, and there are not infrequently dust storms or spells of hot wind blowing off the desert, and laden with dust of a very irritating character. The season is from November to March or April, after which it becomes very warm.

On the whole it is one of the best of climates for phthisical patients and other pulmonary sufferers, for chronic renal and cardiac disease, for many rheumatic patients, and for others who need a warm climate which is also bracing.

FRENCH HEALTH RESORTS

Apart from the Riviera, the only places in France much frequented by English visitors are Pau, Biarritz, and Arcachon, the two latter on the Atlantic coast, the former some little distance inland. Pau is about 600 feet above sea level, and surrounded, but not shut in, by hills. It is somewhat colder than the Riviera, but rather more equable. There is more rain and less sunshine, and the climate is less exciting, therefore better suited to those of nervous temperament.

Biarritz is a bright cheerful place, moderately bracing, though the Atlantic brings a good deal of rain at times. It is a good climate for many moderately robust invalids.

Arachon resembles Bournemouth in being surrounded by pine woods, which are a great protection both against the Atlantic breezes and the winds from the land. It is on a basin connected with the main ocean by a channel; and the climate is rather damp, but free from rapid changes and sedative.

There are, of course, a large number of health resorts, marine and otherwise, frequented by French people, but few are visited by the English, except such as, possessing baths and springs, come under the section of Balneology. There are probably places in the Pyrenees which would meet many requirements, but they have not as yet been exploited for visitors.

GERMANY AND AUSTRIA

What was said about the French health resorts applies very much to those of Germany and Austria, viz., that few except those with baths are frequented by English people. The Black Forest and the Harz Mountains are of course largely visited by tourists, and in Austria Tirol has always a large number of English visitors in summer, some of whom may be invalids.

Meran, however, and in the last few years Innsbruck, both in Tirol, have come somewhat into favour as winter resorts, and a few words should be said about the former. The climate of Meran is, for the most part, sunny, still, dry, and warm. It has an elevation of 1050 feet, and, except to the south, is surrounded by mountains rising up to 10,000 feet, and is therefore well sheltered. The rainfall is small and there is rarely any fog.

It is frequented chiefly by the robuster class of pulmonary invalids, who do not mind the winter cold.

Great features of Meran are the grape cure, which naturally can only be administered in the autumn, and the whey cure, which is given during the spring.

American Health Resorts

Owing to the great distance, the health resorts of America cannot be said to be much frequented by English visitors, but a considerable number of English people go out for reasons of health in the hope of settling down in some part or other, more especially on the high plateau which forms a large portion of the Western States including Colorado, or in Southern California. The enormous size of the country and the amount of development constantly going on seems to offer prospects of employment, often unfortunately unfulfilled, and tempt many who are unable to live and work in the English climate.

Colorado State takes in a considerable section of the Rocky Mountains, which run through it from north to south. The best part for health is on the eastern side of the Rocky Mountains, which there rise almost abruptly out of the plain, already at an elevation of from 5000 to 6000 feet. From the Mississippi westward there is a gradual but almost imperceptible rise until this great elevation is attained. The rainfall is small owing to the protection of the Rocky Mountains Range on the west; and the climate is therefore very dry, with a large amount of sunshine and particularly bracing qualities. In its effects it resembles that of other high altitudes, such as the Engadine, but is much drier, warmer, and comparatively quite free from snow in winter. In fact, snow rarely lies in Colorado Springs for more than a day or two. This is not wholly an advantage, as the dust is one of the great drawbacks of this region, and owing to the high winds, which are not rare in winter, it is very unpleasant; in fact the wind and dust are the great drawbacks to the climate.

The atmosphere is exceedingly clear, and the amount of sunshine very large—considerably greater than that in the Swiss resorts. The temperature rarely falls very low, perhaps touching zero two or three times in the winter, and owing to the dryness the cold is little felt unless there be a wind.

The chief health resort is Colorado Springs, about seventy miles from Denver, the capital of the State. It is a bright, cheerful place with a good hotel, but little other accommodation, unless a house be taken. American boarding-houses are not comfortable according to English ideas, and the smaller hotels are, as a rule, unsatisfactory. Rooms can be got in some private houses in the town, but there is not a very large supply of them.

Denver is a town of 150,000 people, the centre of many railways and a busy, industrial city. It has an elevation of 5300 feet, or some 700 less than Colorado Springs, though really built on the plain, about 15 miles east of the foothills of the Rocky Mountains. It has about 315 sunny days during the year, and a very large percentage of sunshine. It has, of course, a large number of hotels, some of the first class, and some boarding-houses; and there are naturally greater possibilities of employment in such a large city than in Colorado Springs. It is interesting to note that nearly one-fifth of the population are credited to the class that come for climate and health.

Besides Denver and Colorado Springs there are one or two other places in the same region, which may be mentioned. Manitou, about 5 miles from Colorado Springs and nearer the mountains, is more sheltered but gets much less sun. Pueblo, some 30 miles south of Colorado Springs, is a manufacturing city with 35,000 inhabitants, at an elevation of 4700 feet. It has a good winter climate, but is very hot in summer. It is not in itself a very attractive place, and has very little accommodation for invalids.

The summer all over this region is hot, and many people go up into the high mountain valleys or parks, as they are called, at elevations of 8000 to 10,000 feet; the best known of these are Manitou Park, Middle Park, and Estes Park. Some of them have hotels which are only open in summer. As compared with the Swiss resorts, the great advantages of Colorado are the great range of country over which it is possible to move, the greater amount of sunshine, and the greater warmth; the drawbacks are the dust and wind.

The western slope of the Rocky Mountains is much moister than the eastern and much less bracing, but there are many places where an invalid would find a very fair climate. Salt Lake City, with an elevation of over 4000 feet, is an attractive place and a prosperous town, to which a good many invalids resort. In New Mexico and Arizona there are many spots which are well qualified by their elevation, dryness, and sunshine to be health resorts, but they are wholly undeveloped; and Santa Fé, the capital of New Mexico, or Phœnix, in Arizona, would be intolerably dull for a prolonged stay.

Turning to Southern California we find a very different climate, modified by the presence of the Pacific; it has a very mild winter, a hot but bearable summer, and a considerable amount of sunshine. A large number of invalids go there who are unable to bear the cold of the mountain regions, and sufferers from chronic bronchitis, from heart or kidney troubles, and from irritable nervous systems, derive considerable benefit. The chief resorts are Montery, Santa Barbara, and San Diego on the coast, and Riverside, Los Angeles, and Redlands inland. Los Angeles is the capital of Southern California, and has 60,000 inhabitants. Just above it is Pasadena with a very large hotel, filled with invalids in winter. The sea-fogs are at times rather bad on the coast and for some distance inland; the best residence for invalids really is in some of the smaller places on the foothills, but the accommodation outside the recognised resorts is rather rough. A considerable number of English are settled in South California engaged in farming or fruit-growing, but any intending settler is strongly advised to make full inquiries before embarking on such projects.

Florida, like Madeira, has lost most of its reputation as a resort for consumptives owing to the distinctly enervating character of its air and the fact that malaria is not uncommon, but it still attracts a large number of visitors and semi-invalids in winter, and has very good hotels.

British Columbia has a climate with many advantages for invalids—bright, clear, dry, bracing, yet not cold, but, with the exception of Kamloops, 1100 feet, and Calgary, in Alberta Province, 3500 feet, it has no provision for visitors. It is a much less rigorous climate than that of the North-West United States.

SOUTH AFRICA

Now that South Africa has become an exclusively British possession, and the tide of emigration seems likely to set in strongly towards it, there can be little doubt that the many possibilities which it offers to the health seeker will have more attention paid to them than heretofore. The days are long past when Cape Colony was regarded as one of the sanatoria of India, before the Suez Canal was opened, but its climate nevertheless is delightful in summer, *i.e.* during the northern winter, the heat never being excessive, whilst there is a large amount of sunlight with a clear sky and dry atmosphere. The chief rainfall is in May, June, and July. Cape Town is not itself a desirable place for invalids, but Wynberg and Sea Point are both very good.

But it is the climate of the high upland plateau, known as the Karroo, which is specially beneficial to invalids, and here there are many places which in the future should become important sanatoria, and already have considerable reputation. One of the first to be reached is Matjesfontein, at an elevation of 3588 ft. and about 200 miles from Cape Town. The climate is very dry and bracing, with a rainfall of only 5·5 inches, and almost perpetual sunshine. These qualities are characteristic of the Great Karroo, which has an average elevation of 3000 ft., but with mountains rising up to 7000 ft. The summer heat is considerable, but is easily borne owing to the fine air, while the nights are always cool. Beaufort West and Graaff Reinet are both good spots in this district.

In the eastern provinces Grahamstown, 1750 ft., Cradock, 2856 ft., and Tarkasted, 4280 ft., are all beneficial to different classes of cases.

Queenstown, Molteno, near the Stormberg Range, 3544 ft., and Burghersdorp, 4550 ft., 30 miles north, are both attractive places with fine climates.

Aliwal North, 4330 ft. above the Orange River, is well known, not only on account of its climate, but for its mineral springs. A considerable number of pulmonary cases have in the past derived great benefit here from the pure air.

In Natal a delightful climate, somewhat moister than that of the Karroo, but invigorating, is found; and the capital, Pietermaritzburg, 2225 ft., is a good resort for sufferers from bronchial troubles. Howick, 3500 ft., Estcourt, 3800 ft., and the well-known Ladysmith, 3280 ft., all enjoy good climates.

The Orange Free State consists largely of country resembling the Karroo, but considerably higher. The climate is very similar, and the dust is one of the chief drawbacks here as elsewhere. Bloemfontein, the capital, 4518 ft., has long been a resort for phthisical patients, and many have recovered their health here. Bethlehem and Harrismith, both over 5000 ft., have good mountain climates, and the latter is much visited by invalids from Natal.

The Transvaal has many spots which might be utilised for invalids and have considerable elevation, but they are not laid out to attract invalids;

and Johannesburg has a somewhat dangerous climate, marked by rapid changes, and its sanitary conditions are bad.

There are many other places in South Africa besides those mentioned which might be visited by invalids, but enough has been said to show the great climatic advantages which it offers.

Australia and New Zealand

Though generally classed together, there is no similarity whatever between the climates of these countries, and separated as they are by 1000 miles of sea it is more a matter of custom and convenience than anything else which causes their conjunction.

Taking Australia first, it must be said that the coast towns (and all the principal towns lie on the coast) are singularly unfitted for invalids owing to their moist atmosphere and liability to sudden change. The best of them, perhaps, is Adelaide, the capital of South Australia, which has a moderately dry climate, but is liable to great heat. It must be remembered that neither here nor in New Zealand are there any organised health resorts, and there is no provision for invalids or even comfortable accommodation outside the big towns, which we have just said are unsuitable. The up-country towns are for the most part very small places, with probably one or two third-class hotels, very little amusement, and scant society. It may be gathered, therefore, that the number of invalids for whom Australia is suited is very small, save those who come to settle.

The climate of the Riverina and Darling Downs is excellent; warm, dry and bracing, with moderate elevation, it is admirably suited for the phthisical patient, or for sufferers from renal or cardiac trouble, who need a warm yet bracing winter, and the same applies to much of the large inland plateau.

At Orange in New South Wales, 2400 feet, a Government Sanatorium has been established, and this place seems likely to develop. Other towns where moderate accommodation can be found, all on the high inland plateau, but far apart, are Bathurst, Bourke, Deniliquin, Hay, and Tamworth.

New Zealand.—The climate of New Zealand is very much like that of England, but warmer and less humid; there is a fairly heavy rainfall, but much less fog and mist and more sunshine.

The same caution as in Australia must be given with reference to accommodation for invalids, which is almost wholly wanting. The country has many advantages for those who propose to settle, but few for visitors, unless they are in robust health and capable of long coach journeys.

The two extreme ends of the island are unsuited for invalids, the one being semi-tropical, and the other having a climate somewhat resembling the Scotch lowlands.

But there is a considerable area in the provinces of Canterbury and Nelson in the south island, and of Wellington and Napier in the north, which offers very pleasant and healthy settling ground for English emigrants. The towns of the same provinces all have good climates; Christchurch is the best in some ways, but it is hot in summer. Wellington is more bracing, but very windy. Napier and Nelson are both equable climates and fairly bracing in winter.

None of New Zealand is very bracing, unless a considerable elevation be reached, as on the slopes of the Southern Alps, the eastern side of which is very pleasant, the west being very rainy.

In short, the climate is a very pleasant one to live in and seems to suit the Anglo-Saxon race very well, as it admits of a large amount of open-air life, and the atmosphere is remarkably clear and bright; but it has not in most places the stimulating properties which tuberculous patients desiderate, and the country does not lay itself out to attract the travelling invalid.

The Islands of the South Atlantic

These comprise Madeira, the Canaries, Teneriffe, and Grand Canary, which all of course belong to the marine group. Madeira was in great vogue thirty or forty years ago, but has now been almost abandoned, so far as cases of consumption go. It is decidedly moist and somewhat relaxing, with a tendency to depress people after any prolonged stay and to produce digestive troubles and diarrhœa. It is, however, in Sir H. Weber's opinion, well suited for elderly people with much loss of lung and emphysema, especially when complicated with albuminuria, and it is well adapted for sufferers from chronic bronchitis.

The other islands mentioned are situated some degrees south of Madeira and therefore decidedly warmer, but they are drier, and on Teneriffe there is a possibility of attaining some degree of elevation and therefore more bracing effects.

There is good accommodation to be got both in the Canaries and Madeira, but means of amusement are rather lacking, though the scenery is very beautiful and the vegetation luxuriant.

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Third Nerve. *See* OCULAR MUSCLES.

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THE thymus gland is a structure of very variable dimensions in different subjects; its size appears to depend to some extent on the general nutrition, being greater in well-nourished infants than in those who are emaciated. It attains its maximum development at the end of the second year, after which it slowly diminishes in size till puberty, when rapid fatty degeneration takes place and the organ practically disappears, becoming infiltrated with connective tissue, in which, however, remains of the gland may here and there be found. Its average length during the first two years is 2½ ins. (varying between 1¼ and 3½ ins.); its breadth is from ¾ to 1½ ins.; and it weighs from a half to one ounce. It consists of two lobes of unequal size, separated by a mesial fissure, and lies in the superior and anterior mediastinal spaces, and partly in the neck. It extends down to about the fourth costal cartilage, and comes into relation anteriorly with the sternum and costal cartilages, laterally with the pleuræ and lungs, and posteriorly with the pericardium, trachea, and vessels of the neck. In specimens hardened *in situ* by formalin the deep surface of the gland is found to show a concavity for the pericardium and deep grooves for the pulmonary artery, innominate veins, and superior cava (Cunningham). The two lobes of the thymus ascend in front of the trachea to an unequal distance, usually, however, falling short of the thyroid gland, and extending outwards as far as the carotid arteries. The blood-supply is from the inferior thyroid and internal mammary arteries; the nerves of the gland are derived from the vagus and sympathetic.

The thymus is a ductless gland, and consists of a number of lobules separated from one another by connective-tissue septa arising from its sheath. In the clusters of lymphoid tissue which compose the lobules cortical and medullary layers can be distinguished. In the latter the connective-tissue matrix is coarser and the lymphoid cells fewer; and in the medulla, also, the characteristic thymus structures—Hassall's corpuscles—are placed. These consist of concentric layers of flattened epithelial cells surrounding a granular nuclear corpuscle.

The thymus develops about the seventh week of fœtal life as a tubular diverticulum from the third visceral cleft. The walls of the diverticulum are composed of epithelium which proliferates rapidly, and as the diverticulum grows downwards it becomes expanded laterally in its lower part. Finally, the connection between the gland and the pharyngeal cleft from which it arose is severed, and the epithelial structure is invaded and almost entirely replaced by adenoid and connective tissue, the only remnant of its original constituents left in the mature gland being the Hassall's corpuscles already referred to.

Function of the Thymus.—Little is known as to the function of the thymus. In all probability it is the same as that of the lymphatic tissues elsewhere, the thymus juice containing numerous leucocytes which find their way into the general circulation through the veins of the gland.

From the fact that it is usually persistent and enlarged in cases of Graves' disease, and sometimes in acromegaly and myxœdema, the idea suggests itself that it may have some function (an internal secretion?) correlated with that of other ductless glands. Svehla found that the intravenous injection of thymus extract produces (in dogs) a great fall in the blood pressure and acceleration of the heart, and, in lethal doses, dyspnœa and collapse. But in reality little is known as to the physiology of the organ.

Diseases of the Thymus.—The thymus is for the most part inaccessible to the ordinary methods of physical examination, though in young infants a little dulness may be made out over the upper part of the sternum as low as the third rib. The majority of the morbid changes to which the organ is liable are, either because of their rarity or because they are insusceptible of clinical diagnosis, of pathological interest alone. Only one condition, in fact,—hypertrophy of the thymus,—is of any practical importance; the other diseases of the organ may be dealt with very briefly.

1. *Tuberculosis* is on the whole rare. It may occur as a primary lesion, but is more commonly part of a generalised tuberculosis. Jacobi found it thrice in children under one year, in each case as a part of a generalised miliary tuberculosis.

2. *Syphilis.*—In cases of hereditary syphilis the usual vascular lesions and increase of connective tissue are sometimes found. Small multiple abscesses are also said to occur, but there is some doubt as to whether these are really of an inflammatory nature, as the secretion of the thymus gland bears considerable resemblance to pus.

3. *Inflammation and Abscess Formation.*—Though rare, there seems no doubt that some cases of mediastinal abscess have had origin in the thymus. Chronic inflammation of the capsule may occur secondarily to pleurisy or mediastinitis. Necrotic foci were found by Jacobi in some cases of diphtheria.

4. *Tumours, etc.*—Sarcomata, lymphadenomata, carcinomata, lipomata, cysts, of uncertain origin, containing clear yellowish serum, and possibly other tumours, may develop in the thymus gland.

5. *Hæmorrhages* are not infrequently found, both in cases of "thymus-death" and apart from that condition in young infants dying of atelectasis, convulsions, whooping cough, asphyxia neonatorum, or, in short, of any disease attended by circulatory disturbance. They may in some cases be due to syphilis or to hæmophilia.

6. *Enlarged and Persistent Thymus.*—This is met with in the adult in several conditions, notably in exophthalmic goitre, of which it is a frequent accompaniment. As a lymphoid organ the thymus is also often enlarged in leukæmia. Less constantly, but still with sufficient frequency to warrant notice, we find described persistence or enlargement in acromegaly, Hodgkin's disease, and myxœdema. Except in leukæmia and Hodgkin's disease the relation of the enlargement to the general malady is obscure. In these conditions the enlargement is clinically unimportant, but such is not the case where we have an enlarged thymus, either in children or in adults, apart from another general disease.

Simple Enlargement (Hyperplasia) of the Thymus.—Much interest attaches to this condition, though it cannot yet be said that perfect clearness prevails as to its relation to fatal dyspnœa or cardiac failure. The cases fall into two groups:—(1) Those in which the fatal issue is preceded for some days or weeks by symptoms of interference with the functions of respiration or circulation. (2) Those in which death takes place with absolute suddenness. In the latter, again, the sudden death may occur either spontaneously or after some quite inadequate external cause, such as a hypodermic injection, the examination of the pharynx with a spatula, the administration of an anæsthetic, etc.

1. *Chronic Progressive Dyspnœa due to Enlarged Thymus.*—It may now be regarded as proved that an enlarged thymus may, though rarely, cause dangerous progressive dyspnœa. Siegel's case furnishes a good example of this: a boy aged two and a half years had suffered from dyspnœa for four or five weeks; there was considerable stridor, with paroxysmal exacerbations, in which the child seemed moribund from asphyxia. No laryngeal obstruction could be detected. Tracheotomy failed to give relief until a tube long enough to reach down to the bifurcation of the trachea was inserted; while this was worn complete comfort was experienced, but when it had to be removed after a week or two on account of pressure ulcers the symptoms returned as badly as before. A small zone of dulness was detected over the upper part of the sternum, and on opening the superior mediastinum the thymus bulged into the wound, and was drawn out as far as possible and sutured to the fascia over the sternum—a proceeding which at once gave complete and permanent relief to the dyspnœa.

Enlarged thymus may cause death by pressure on important structures other than the trachea. Thus Rolleston records the case of a boy aged six who suffered for three weeks before death from cough and stridor, but no great dyspnœa, together with distension of the veins of the neck and swelling of the neck itself. The patient died suddenly of heart failure, probably from cardiac dilatation resulting from interference with the function of the pneumogastric nerves, which were found to be pressed on by a greatly enlarged thymus.

A third case, interesting as forming a connecting link between these and the cases of absolutely sudden death about to be described, is reported by Kohn. An infant, aged seven months, had been fretful and restless for two days. The child suddenly became seriously ill, the face being pale and slightly cyanosed, the respiration fluttering, but free from stridor, and the pulse imperceptible. Death occurred in a few hours. On *post-mortem* the thymus measured 3⅛ ins. by 2⅜ ins. by 1½ ins. The respiratory organs were healthy, there was no sign of pressure on the trachea or nerves, but the aortic arch was slightly compressed and the heart markedly hypertrophied and dilated. There was also enlargement of the lymphatic structures of the body generally. The writer believed that the thymus had compressed the aorta and thus caused cardiac dilatation.

2. *Acute Cases.—Thymus Death; Thymic Asthma.*—As an example of sudden "*Thymus-Tod*" one of Grawitz's cases may be cited, which is not only typical of very many of those recorded, but is of importance from the fact that his paper directed the attention of observers anew to the question at a time when Friedleben's authoritative dictum "there is no thymic asthma" had been almost universally accepted for just thirty years. The patient was a little girl, strong and healthy, who had never suffered from cough or any other illness. Her father was carrying her on his arm and playing with her in the presence of some friends. Suddenly the child seemed to choke, became cyanosed, clenched her fists, and died in a few moments, artificial respiration proving useless. The *post-mortem* showed moderate rickets; the thymus measured 3 ins. by 2⅜ ins. by ¾ in., overlapping the greater part of the heart and reaching as high as the thyroid. No other morbid appearance was present. So many cases exactly resembling this one are on record that it must be taken as certain that enlargement of the thymus, in some way or another, is a cause, or, to say

the least, a frequent concomitant of sudden death in infants. As to the nature of such cases, however, there is much uncertainty.

In the earlier part of the century it was universally held that enlargement of the thymus caused a form of asphyxia to which the name of thymic asthma was given; in some cases it proved fatal, as in that just described, in others it was recovered from. No doubt in most instances such patients really suffered from laryngismus stridulus, which gives rise to symptoms like the above, and may prove fatal in its first seizure. From the fact, however, that enlarged thymus was found in *some* cases of sudden asphyxia it was believed that *all* had the same cause, and that laryngismus was due to enlarged thymus, acting either by pressure on the recurrent laryngeal or otherwise. It was also accepted that an enlarged thymus might cause fatal asphyxia by direct pressure on the trachea. In 1858 Friedleben's monograph appeared, and from a critical study of clinical records, as well as from an elaborate series of measurements of the thymus, he concluded that in many cases of so-called enlargement the organ was within normal limits, or at least that an equally large thymus might be found in otherwise healthy children, and argued that so-called hypertrophy of the gland had no significance in cases of sudden death. For more than twenty years his views prevailed, and the term "thymic asthma" was almost forgotten. Virchow and Cohnheim, however, still maintained the possibility of an enlarged thymus causing fatal asphyxia. "I possess a preparation," says the former, "from a child who died from asthma, in which the thymus is so greatly enlarged that I cannot see how one can deny the possibility that the dyspnœa was caused by its pressure." The size of the organ was $3\frac{5}{8}$ ins. by $2\frac{1}{2}$ ins. by $\frac{3}{8}$ in.—almost the same as in Grawitz's case. In the early eighties opinion began to veer round to the idea that enlarged thymus might not be so harmless as Friedleben had taught, and Jacobi clearly pointed out that while many cases of sudden death were due to laryngismus, and had nothing to do with the thymus, there remained a residuum which were caused by thymic enlargement. Similar opinions were expressed by Rauchfuss, Baginsky, and others. It is not possible here to enter fully into all the arguments adduced, but the following are some of the difficulties which arise in connection with this matter:—

Paltauf has shown that capillary bronchitis as a cause of death is very apt to be overlooked in young infants unless the smaller bronchi are carefully slit up with fine scissors, and that many cases of sudden death which on too hasty examination might easily have been ascribed to enlarged thymus were due to this cause.

1. *Mechanical Effects of Enlarged Thymus.*—In most cases direct evidence of compression of the trachea is absent. As Paltauf points out, this cannot be decided unless special precautions are taken, and, instead of the thorax being opened in the usual manner, the upper part of the trachea is dissected out, and its interior examined from above while the thymus and sternum are *in situ*. Beneke, adopting this method in two cases of sudden death, found that the trachea was somewhat flattened, while if the head was bent backwards its lumen was entirely occluded. He thought that weakness of the neck muscles, allowing the head to fall suddenly backwards, was a factor which must be taken into consideration in such cases. In some instances the symptoms have been those of heart failure rather than of asphyxia, and it has therefore been thought that the pressure may affect the vessels or nerves at the root of the neck and thus cause syncope, or if the recurrent laryngeal be involved, glottic spasm. It must be admitted that this seems plausible, especially if one remembers how close is the rela-

tion of the innominate veins to the gland, and also that a very considerable force is required to compress and occlude the trachea. An obvious objection to all mechanical theories is the difficulty of supposing that a chronic enlargement can, without previous warning, give rise to acute pressure symptoms, which is partially met by Beneke's suggestion that sudden alterations in the position of the head may lead to the compression of important structures. It must also be borne in mind that it is not uncommon to meet with sudden death from other causes (*e.g.* aneurysm) in apparently healthy people, in which the autopsy reveals such lesions as might assuredly have been expected to produce symptoms, and yet apparently never did so. The difficulty that not all children with enlarged thymus die suddenly, or from causes connected with the glands, is more apparent than real, because in the case of an organ whose shape and, to a less extent, position are variable, a great deal must depend on the exact form which the enlargement takes as to whether pressure will be exerted or no, while the conjugate of the inlet of the thorax has also to be considered in this connection. It should be pointed out that, on anatomical grounds, it is doubtful whether sudden vascular engorgement of the thymus can account for such an increase in its size as to lead to compression of adjacent parts, nor is there any evidence of sudden secretory activity and swelling being possible.

2. *Status Lymphaticus, Lymphatism.*—A new aspect of the question is opened up by Paltauf's researches. On his view the enlargement of the thymus is but one, though the most obvious, of the signs of what he calls the lymphatic constitution (*status lymphaticus*), and, further, persons who are the subjects of this diathesis are specially prone to fatal syncope. In such cases the body is well nourished and the skin very pale. Rickets is generally present. The viscera show no material structural alteration. The spleen is usually enlarged, with distinct follicles, and the other parts of the lymphatic system—glands, lymphoid tissues in the nasopharynx and root of the tongue, Peyer's patches, and lymphoid tissue of the intestines generally, and also the thymus gland—are markedly enlarged.

The lymphatic constitution is not limited to childhood, but is sometimes found in adults, and in these cases there is usually narrowing of the aorta and dilatation of the heart, with signs of degeneration of the muscular fibres. Nordmann's cases of adults who died suddenly while or immediately after bathing, in whom enlarged thymus was found, are referred by Paltauf to the same category. The sudden death he attributes entirely to syncope, and believes that the abnormal nutrition of the body carries with it a certain liability to cardiac failure as the result of any external stimulus. Paltauf's view is strongly supported by Escherich, according to whom lymphatism is very commonly met with in children dying of diphtheria, and must therefore be looked upon as a most unfavourable complication of this or any other infectious disease. The same writer also believes that the diathesis goes along with a predisposition to laryngismus stridulus, and that when the latter proves fatal the patient will almost invariably be found to show signs of lymphatism. He points out that many of the cases of sudden death, in which enlargement of the thymus was present, there was also laryngismus, but does not think that the mechanical obstruction to the entrance of air through the glottis is the immediate cause of death (for one reason, artificial respiration is useless), but that the shock which the glottic spasm causes produces fatal syncope. In the only case of fatal laryngismus which Jacobi examined *post-mortem* he attributed death to the presence of a thymus weighing nearly an ounce.

If Paltauf's and Escherich's views be accepted the idea that death is primarily due to asphyxia must be discarded, and from the accounts of cases, as well as from the fact that in some (as seems to have been satisfactorily established) the heart stopped beating before the respiration failed, this appears to have much to commend itself. The suggestion will at once present itself that possibly the action on the heart may be due to an auto-intoxication—perhaps to an internal secretion of the thymus. Svehla's work, already referred to, seems to show that in dogs the injection of thymus extract causes a fall in blood pressure from vasomotor paralysis, and acceleration of the heart from direct action on the cardiac ganglia. In lethal doses the effects resembled the signs of thymus death—restlessness, dyspnœa, and collapse.

Taking everything into consideration, it would seem that the views of Paltauf have much to commend them if for no other reason than they form an hypothesis which (even if insufficiently proven) reconciles most of the otherwise discrepant facts. Firstly, they connect enlarged thymus with glottic spasm; and, secondly, they explain why death seems to occur in most cases from syncope rather than asphyxia. They do away with the necessity for explaining why some thymus glands should compress the trachea, while others equally large do not do so, and they bring cases of sudden death in children, whether spontaneous or from some trivial cause, into line with similar cases in the adult. Finally, they show why a chronic disorder may suddenly show itself by acute symptoms. On the other hand, on purely mechanical grounds it seems not unlikely that an unusually large thymus may contribute towards death, at least in a young infant. It must diminish the capacity of the thorax, press on the lungs and heart, and, from its intimate relation to the large vessels and nerves, lying as they do within a small cavity whose walls are comparatively rigid, one can readily see that a very slight alteration in the size of the gland, or, it may be, a sudden twisting of the neck, might lead to such an alteration in the relative positions of these structures as to cause fatal results.

From what has been said it would seem that the following conclusion can be drawn:—(1) In cases of chronic dyspnœa unrelieved by tracheotomy the possibility of enlarged thymus should be thought of, and the superior mediastinum opened and the gland pulled forward. (2) In cases of sudden death in infants, and perhaps in older persons, the presence of enlarged thymus, especially if the other appearances of the lymphatic constitution are present, is *prima facie* evidence of death from natural causes. The importance of this in medico-legal cases (*e.g.* charges of over-laying) is self-evident. (3) The recognition of the lymphatic constitution during life (*a*) contraindicates many of the more energetic, though ordinarily safe therapeutic measures—general anæsthesia, packs, etc.; (*b*) adds to the gravity of the prognosis in infectious diseases; (*c*) gives reason for anxiety in laryngismus stridulus.

Treatment.—In chronic cases with signs of obstruction to the respiration the line of treatment has already been indicated. When the status lymphaticus is recognised the measures to be adopted are those in use in cases of scrofula, together with the avowance of anything likely to cause syncope. In cases of heart-failure no method of resuscitation has hitherto proved of the slightest use.

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Thyroid Gland.

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Anatomy and Physiology

Anatomy.—The thyroid gland is composed of three parts—the two lateral lobes and the isthmus. Each lobe is about two inches long and somewhat oval in shape, the upper end being narrower and more pointed than the lower. The whole gland is of a dark reddish-brown colour, and in the adult weighs from an ounce to an ounce and a half. The gland receives an abundant blood-supply from the thyroid arteries, which anastomose freely, and end in a network of capillaries for each alveolus. The veins unite and form the superior, middle, and inferior thyroid veins. The lymphatics take origin from the lymph spaces of the connective tissue which surround each alveolus. They unite and ultimately open into the jugular lymphatic trunk, which on the left side opens into the thoracic duct, and on the right into the right lymphatic duct.

The gland is invested by a fibrous capsule, extensions of which run into the gland, and subdivide into a supporting framework for the vesicles of the gland.

The gland consists of a number of alveoli which are rounded or polyhedral, with a diameter varying from 0·045 to 1 mm. A few of the follicles appear as a mass of cells; in the great majority, however, there is a central space filled with the colloid substance. Each alveolus is lined by a layer of epithelial cells, two kinds of which may be distinguished—the chief cells which are cubical in shape, measuring from 8 μ to 16 μ in height by 6 μ to 8 μ in breadth, and the colloid cells which measure from 7 μ to 9 μ in height.

The colloid substance which fills the centre of the alveolus is a glairy fluid and yellowish in colour, and in it red blood corpuscles, leucocytes, and epithelial cells may sometimes be seen. The colloid substance is secreted by the epithelial cells which line the alveolus, in the lumen of which it is stored till required. As the gland has no duct the secretion is conveyed from the gland by the lymphatics, and possibly also by the veins. It was shown by King and by Horsley that the colloid substance could be squeezed from the centre of the acinus into the lymphatic spaces which lie outside and between the alveoli. Thence it passes directly into the lymphatic vessels which drain the gland. Hürthle has shown that the colloid escapes from the alveolus, either by rupture of the alveolar wall, or by passing through minute channels between the epithelial cells into the interacinous lymphatic spaces. The secretion of the gland is thus mixed with the lymph with which it passes into the general blood stream, and is distributed all over the body.

PHYSIOLOGY.—The thyroid gland is thus a ductless gland, the function of which is to supply an internal secretion which is poured into the blood. The important part played by this secretion in the general metabolism of the tissues is shown by the results of removal of the thyroid gland in man and lower animals. Thus in rabbits removal of the thyroid gland is followed by the gradual development of hebetude, swelling of the subcutaneous tissues, dryness of the skin, loss of hair, and subnormal temperature, all of which are symptoms of myxœdema in man. It was shown by Horsley that in the monkey especially, thyroidectomy was followed by symptoms closely resembling those of myxœdema in man. In my own experience similar symptoms have also developed. Some five days after the operation a fine tremor of the limbs appears, and the animal loses all its natural liveliness, and becomes inactive and apathetic. There is progressive loss of muscular power, and the animal sits huddled up in a corner of its cage. Tonic and clonic contractions of the flexor muscles are often seen, and true epileptic fits occur in some cases. The temperature at first is irregular, but later becomes subnormal. From two to three weeks after the operation myxœdematous swelling appears in the face, the skin becomes dry, and the hair may be lost in places. It is thus evident that the symptoms closely resemble those of myxœdema in man. They develop more acutely, of course, because the gland is removed all at once instead of undergoing a progressive fibrosis as in primary myxœdema in man. In secondary myxœdema in man, however, the symptoms may develop almost as rapidly as in a case transferred to my care at the Newcastle Royal Infirmary, by my colleague Mr. A. Martin, who had removed the whole of the gland for disease. Within ten days of the operation there was swelling of the face and tongue, dryness of the skin, slow speech with attacks of tetany, just like those which occur in the monkey.

In young animals removal of the thyroid gland is followed by arrest of development in addition to the other symptoms, so that a condition of cretinism is the ultimate result.

In man, as we shall see in considering secondary myxœdema, removal of the thyroid gland in the adult is followed by typical myxœdema. When the gland has been removed during childhood there has been an arrest of development as well, and the child has become a complete cretin.

When the importance of the thyroid gland was first demonstrated, it was thought that the results of thyroidectomy in an animal might be averted by grafting a piece of another gland into the animal. Schiff and von Eiselsberg showed by their experiments that in the cat and in the dog, a piece of a thyroid gland successfully transplanted was able to supply sufficient secretion to ward off the symptoms which usually follow thyroidectomy in these animals. Sir Victor Horsley then suggested that a similar method of treatment should be adopted in man for myxœdema, so as to arrest the inevitable downward progress of the disease to a fatal termination. Marked improvement followed this operation, notably so in cases recorded by Bettencourt and Serrano, by Bircher, and more recently by Dr. M'Pherson at Stirling. Unfortunately, in most of the cases thus treated it has been found that the grafted gland after a time shares the fate of the original gland and atrophies. It occurred to the writer that the supply of secretion might be continuously maintained by the internal administration of it, in the form of a glycerine extract of the sheep's thyroid gland. He selected the hypodermic method, and was soon able to show that when the supply of secretion was thus continuously maintained, the symptoms entirely disappeared in an advanced case of myxœdema. It was subsequently shown by Prof. Howitz, in Denmark, and by Dr. E. L. Fox and Dr. Hector Mackenzie, in England, that the same result was obtained more conveniently when the thyroid extract was given by the mouth.

These observations thus shortly described indicate clearly that the function of the gland is to supply an internal secretion to the blood, which plays a very important part in maintaining the normal metabolism of the tissues generally, more especially of the central nervous and cutaneous systems in the adult, and of the growing bones in the young.

THE PARATHYROID GLANDS.—Closely associated with the thyroid gland in animals are the parathyroid glands. In rabbits, cats, and dogs these glands can be removed separately from the thyroid gland. In the monkey they are embedded in the thyroid gland, and in thyroidectomy are removed along with it. We know nothing definitely yet of the results of disease of these glands in man, though it has been suggested that they may be affected in exophthalmic goitre. Experimental removal of the parathyroids alone in animals has been followed by acute nervous symptoms, such as muscular tremors, clonic and tetanic contractions of voluntary muscles, loss of power, and emaciation. So that there is good evidence to show that they have some important function, and that further investigation will throw more light on their function in man.

MYXŒDEMA

ETIOLOGY.—*Sex.*—Myxœdema is much more common in women than in men, as it occurs almost seven times as frequently in the former as in the latter.

Age.—Myxœdema rarely develops before twenty, after that it becomes more frequent each succeeding five years up to the age of forty-five, after which it gradually becomes less frequent. Thus in about one-third of all the cases the onset is between thirty-five and forty-five.

Locality.—Cases of myxœdema occur most frequently in temperate climates, and are rare in the tropics. They appear to be more common in Great Britain, especially in the north of England and south of Scotland, than in other European countries. The disease is well known in America and in Australia, but the coloured races are apparently exempt from it.

Heredity.—A certain predisposition to thyroidal disease occurs in some families, so that myxœdema may occur in one member, while some other form of thyroidal disease occurs in another. In some families a mother and daughter, two sisters, or a brother and sister, have suffered from myxœdema.

Antecedents.—In a certain number of cases myxœdema has been preceded by exophthalmic goitre, and it is evident that recovery from the latter predisposes a patient to the development of the former. This can be easily understood if we remember that the development of fibrosis and atrophy of the enlarged gland, which is a natural method of recovery in exophthalmic goitre, will, if it progresses too far, of necessity lead to the development of myxœdema.

Excessive child-bearing appears to be another predisposing cause, for we find that the majority of cases are in women who have borne children.

Of the actual exciting cause of the thyroidal fibrosis, in the great majority of cases we know nothing. In one recorded case, syphilis, and in another, actinomycosis of the thyroid gland caused the myxœdema.

SYMPTOMS.—*Onset.*—The symptoms of myxœdema develop slowly, and months may elapse from the commencement of ill-health before they become well defined. The length of the period of development depends upon the progress made by the atrophic cirrhosis of the thyroid gland, which is usually very gradual. In a few cases, especially in young adults, the symptoms have developed more rapidly, so that the nature of the disease was recognisable a few weeks, or even days, after the onset.

At the commencement a feeling of lassitude is often experienced, which gradually increases till even slight exertion becomes toilsome. This may be struggled against for a time, but sooner or later the patient is compelled to abandon active pursuits and lead a more or less sedentary existence. A feeling of chilliness on cold days is complained of at an early stage, which increases till there is a continued feeling of coldness, except in hot weather or when the temperature of the room is high. The temperature, which in the early stages may still be normal, later on falls one or two degrees lower.

The subcutaneous tissues gradually become distended by the myxœdematous swelling, which entails considerable alteration in the appearance of the face. At the first there is only an increased fulness and rounding of the features, which is most conspicuous round the eyelids and beneath the chin. The centre of each cheek is often flushed, though the skin of the rest of the face, in many cases, gradually becomes yellowish in colour. The lips are slightly thickened and the forehead transversely wrinkled. Careful examination will reveal the presence of a solid elastic œdema in the subcutaneous tissue in other parts of the body, notably above the clavicles, on the back of the hand and on the dorsum of the foot. Perspiration is diminished, so that the skin gradually becomes dry and wrinkled. The skin over the extensor aspect of the knees and elbows is specially liable to be rough and dry, even at an early stage. Subjective nervous symptoms may be present, thus both visual and auditory hallucinations may occur at a time when objective symptoms of the disease are only slightly developed.

Cutaneous System.—One of the most striking features of a fully developed case of myxœdema is the condition of the skin and subcutaneous tissues. Wherever the skin is loose, owing to the laxity of the subcutaneous tissues, the latter becomes distended by the characteristic solid œdema. Thus the face is full and rounded, and the eyelids are distended as if with the watery œdema of Bright's disease. The supra-clavicular fossa, the back of the hand, and the dorsum of the foot are swollen also. All over the trunk and limbs a similar change can be observed, though here it more closely resembles an increase in the subcutaneous fat or the general œdema of renal disease. On palpation the swelling does not pit and feels more elastic than fat, and if the skin is punctured no serous fluid escapes. The appearance of the face is profoundly altered, as in addition to the swelling of the eyelids the cheeks may be pendulous, and the lips are thick and everted. The palpebral fissure is narrowed from falling of the upper eyelid, which is to a certain extent counteracted by the instinctive contraction of the occipito-frontalis muscle, causing well-marked transverse wrinkling of the forehead. The nose and ears are also thickened, so that the appearance of the face is greatly altered, and it has a stolid, fixed expression, in consequence of which all advanced cases of myxœdema to a certain extent resemble each other. There may be a considerable increase in weight, and the solid œdema in some cases limits the mobility of the joints, so that there is difficulty in stooping or in bringing the hand up to the back of the neck.

The skin is dry and rough, as the secretion of the sebaceous and sweat glands ceases, and it feels cold to the touch. The superficial layers of the epidermis are frequently shed as a fine white powder. The skin of the face is yellowish in colour in some cases, in others it is white, while the centre of each cheek is usually occupied by a bright red flush due to dilatation of the small cutaneous veins. On the extensor aspects of the joints, and on the palms of the hands and soles of the feet, the skin becomes very hard and dry, and may be cracked. On the back of the hand it is often wrinkled.

The hair is generally fine in texture and soft to the touch. On the head it is generally scanty, and in advanced cases there may be almost complete baldness, while the skin of the scalp becomes dry and scaly. Hair in other parts of the body may also be scarce or absent. The nails may be grooved and cracked, while the teeth are often carious. The mucous membrane of the mouth and nose is dry, and on the lips it is often pale and swollen as well.

The Thyroid Gland.—The thyroid gland is diminished in size in nearly all cases. In some it cannot be felt at all, and in others only the atrophied isthmus can be detected lying in front of the trachea. Rarely in slight cases it is larger than normal.

Temperature.—A sensation of chilliness may be complained of at an early stage, while in the later stages a feeling of coldness is a common symptom. This is naturally more marked in cold than in warm weather, so that in the winter much time is spent sitting close to the fire. In the early stages the temperature may be normal, but as the disease advances it gradually falls lower, and may be only from 93° F. to 95° F., or even lower before death.

Nervous System.—The functions of the nervous system are performed more slowly than in health. Thus there is marked slowness in the comprehension and also in the execution of anything new. The memory becomes defective, especially for names of people and things, and for recent events. The temper is generally placid and even. Daily duties, such as dressing and eating, are accomplished very deliberately and take up much time. Patients are often very sensitive about the alteration in their personal appearance, and consequently are apt to be shy. Sleep at night is good, and drowsiness may be felt during the day. Auditory and visual hallucinations are not uncommon, even in the early stages of the disease. Some ill-defined object may be seen moving rapidly across the floor, or some well-known figure may be actually seen. A noise like that caused by the opening of a door or actual voices may be heard. The patient is always fully conscious of the subjective nature of these phenomena.

Actual insanity occurs in some advanced cases of myxœdema, but now that suitable treatment is usually adopted at an early stage of the disease such cases are uncommon. The form of insanity has generally been acute or chronic mania, dementia, or melancholia.

All voluntary movements are slow. The gait is slow and awkward and the speech is deliberate. A general muscular weakness is not uncommon, and the legs may give way suddenly while the patient is standing or walking, so that she falls to the ground. Various subjective sensations may be complained of. Chilliness has already been mentioned. Headaches and neuralgic pains in various parts of the body are not infrequent. Giddiness occurs in some cases. Sensory impulses appear to be conveyed more slowly than in health, but the slowness of response may be partly due to the mental hebetude.

The special senses are often impaired. Thus the Myxœdema Committee of the Clinical Society found that in a small number of cases a general diminution of visual power and watering of the eyes were present. Hearing is more or less defective in half of the cases. I have seen with Dr. Dalgleish a woman who had been almost completely deaf, but whose hearing suddenly returned while she was being treated by thyroid extract. Taste and smell are impaired in some cases. Sexual feeling is usually diminished, and the power of reproduction is not usually retained in either sex.

Circulatory System.—In many cases, and especially in the early stages, the heart is unaffected. In advanced cases symptoms of fatty or fibroid degeneration of the cardiac muscle, such as dyspnœa, palpitation, and syncopal attacks are not uncommon. In such cases the cardiac impulse is feeble and the heart sounds are weak. These cases require special care when treated by thyroid extract, as they are not fit for additional exercise till long after the improvement in the general condition would appear to warrant it.

The pulse is generally less frequent than in health, regular, and of low tension.

A moderate degree of anæmia is generally present; in some cases there is well-marked pallor. The red corpuscles, however, rarely fall below 3,000,000 per cubic millimetre, while the hæmoglobin may fall to 60 or 70 per cent, or even as low as 40 or 50 per cent. Hæmorrhages are not uncommon, especially from the uterus at the menstrual period or during parturition. Bleeding may also take place from the nose, gums, throat, or bladder.

Digestive System.—Constipation is a common symptom, and dyspepsia occurs in some cases. The teeth are generally brittle and carious. The tongue is distinctly swollen in some cases. Hæmorrhoids are often present.

Urine.—The urine is usually normal in character. In some advanced cases the urine has a low specific gravity, varying from 1·008 to 1·018. In about one-fifth of the cases a small amount of albumin is present. If no renal disease is present the albuminuria disappears along with the other symptoms under treatment.

MORBID ANATOMY.—*The Thyroid Gland.*—The thyroid gland is much diminished in size, and the weight is reduced in advanced cases to from fifty to seventy grains, or only about one-tenth of the normal weight. It is pale in colour and tough, and fibrous in consistence. Microscopical examination shows that there is a more or less advanced atrophy of the glandular epithelium with general fibrosis of the whole gland. In advanced cases only a few alveoli may remain lined with epithelial cells and filled with colloid, while in some very advanced cases the whole gland is converted into fat and fibrous tissue, and not a single alveolus can be found in transverse section of one lobe of the gland. Such changes naturally lead to a gradual diminution and final arrest of the secretory activity of the gland.

Skin.—The skin is thickened as in life, and on section is somewhat translucent. The epidermal epithelium may be partly atrophied. The trabeculæ in the connective tissue of the corium are replaced by bundles of fine nucleated fibrillæ, and in some specimens the interfibrillar spaces are widened. In some cases there is endarteritis of the vessels. The sebaceous and sweat glands are partly atrophied. The hair follicles are surrounded by nucleated fibrous tissue, which in the later stages of the disease may contract, leading to compression and atrophy of the root sheath and loss of hair. There is a considerable increase of subcutaneous fat in many cases.

Nervous System.—No constant changes of importance have been found in any part of the nervous system. The hypophysis cerebri has been found to be enlarged in a few cases, the increase in size being due to hypertrophy of the anterior glandular portion.

Circulatory System.—In early cases no special changes are found in the heart or blood-vessels. In advanced cases interstitial myocarditis is found, and as a late result of this there may be fatty and fibrous degeneration of the cardiac muscle.

Atheroma is commonly found in the larger arteries, and endarteritis in small vessels in all parts of the body.

Kidney.—Moderate cirrhosis of the kidney is frequently found, and with it there may be hypertrophy of the left ventricle of the heart.

PATHOLOGY.—*General Pathology.*—In considering the physiological functions of the thyroid gland we have already seen that myxœdema can be induced in lower animals by removal of the thyroid gland. In man we also know that primary myxœdema is always the result of destructive disease of the gland, and secondary myxœdema only occurs as the result of the removal of the gland by operation for goitre or malignant disease. We shall also see in considering the treatment that the symptoms of the disease can be entirely removed by maintaining a constant supply of the secretion in the form of thyroid extract. It is thus evident that the symptoms of the disease in man are solely and entirely due to destruction of the thyroid gland and the consequent lack of an adequate supply of its secretion to the blood.

Chemical Pathology.—In the early stages of myxœdema there is probably an increase of the intercellular ground substance in the skin, which yields an excess of mucin. An excess of mucin was found by Dr. Charles, who examined the skin in Dr. Ord's first recorded case. In other cases, however, no excess has been found, probably, as Professor Halliburton suggests, because the patient died in the atrophic stage of the disease. The same observer has found an excess of mucin in the tendo-Achillis and in the cardiac tendons. The parotid gland in one case yielded 0·188 per cent of mucin, whereas in health it contains only a trace.

DIAGNOSIS.—In a well-marked case of myxœdema diagnosis is easy, and can be readily made from the description of the appearance and symptoms already given. It is, however, important to bear in mind that in the early stages of the disease the appearance is much less characteristic, and the symptoms are much less obvious, so that slight cases may be easily overlooked. Languor, loss of energy, and loss of memory generally occur early, and in a middle-aged woman should always arouse a suspicion of myxœdema. At an early stage some swelling of the face, hands, legs, or feet can generally be detected when looked for, and the skin will be found to be drier than it should be. If any doubt exists as to the nature of the symptoms a course of treatment with thyroid extract will soon settle the question. If there is myxœdema these symptoms will gradually disappear in the course of six or eight weeks' treatment; if not, no improvement will be observed.

From renal disease myxœdema may be distinguished by the solidity of the swelling and by the absence of albuminuria, or at most the presence of only a trace of albumin in the urine, but it must be remembered that in some cases of myxœdema there is chronic granular kidney as well.

In acromegaly there is an actual enlargement of the bony and other structures of the face and limbs, which gives quite a different aspect to the patient to the subcutaneous swelling of myxœdema.

PROGNOSIS.—Formerly the prognosis of myxœdema was a gloomy one, as the disease gradually progressed to a fatal termination. At most some temporary arrest or slight improvement during warm weather was to be expected. The duration was not uncommonly as much as five or ten years, and in a few cases twenty or thirty. Now the prognosis is very favourable, as under treatment all the symptoms in any early case disappear and do not return as long as a sufficient amount of thyroid extract is taken. In more advanced cases also, if no incurable degeneration of an important organ has occurred, complete recovery takes place. Thus my first case, who began to be treated in 1891, more than eleven years ago, still takes one drachm of thyroid extract in the course of each week, and remains quite free from any symptoms of myxœdema.

The presence of well-marked cardiac degeneration, renal disease, or insanity, naturally increases the gravity of the prognosis, though even in these cases great improvement may take place.

Treatment.—In the treatment of myxœdema the thyroid gland may be employed in several different forms. The raw, fresh gland of the sheep may be given finely minced and mixed with glycerine, the usual dose being from one-eighth to one-quarter of a lobe. As a rule, however, it is much better to employ one of the two official preparations, liquor thyroidei or thyroideum siccum. On the average each lobe of the sheep's thyroid gland yields eight grains of dry thyroid powder, or 48 minims of thyroid extract. Thus, one-eighth of a lobe of the fresh gland = ♏vj. of liquor thyroidei = gr. j. of thyroideum siccum. The liquor should be prescribed undiluted, the dose being measured out in minims, and water added at the time it is taken. It is advisable to obtain a fresh supply once a fortnight. Dry thyroid may be prescribed in either a powder, pill, or tablet.

The treatment of a case of myxœdema is conveniently divided into two stages. During the first our object is to get rid of all the symptoms, and so restore the patient to health; during the second stage we have to maintain the condition arrived at by the first. It must, of course, always be remembered that cessation of treatment will be followed by a return of the symptoms. During the first stage of the treatment of an advanced case of myxœdema it is advisable to keep the patient in the house, or even in bed if any symptoms of degeneration of the cardiac muscle are present, such as feeble or irregular pulse, dyspnœa on exertion, or weak heart sounds. In such cases only a small dose should be given at first, three minims of thyroid extract or half a grain of dry thyroid each night at bed-time being sufficient for the first week. If this dose is well borne, it may be gradually increased up to ten or twelve minims of the former or two grains of the latter preparation by the end of the second or third week. This dose may be continued steadily until all the symptoms of the disease have disappeared, when the first stage of the treatment is completed.

The second stage of necessity lasts as long as the patient lives. During this stage it is necessary to give an amount of thyroid extract each day equivalent to the daily output of secretion from a healthy thyroid gland. As a rule one drachm of liquor thyroidei each week is quite sufficient, ten minims being taken every week-day at bed-time. Thus, for example, my first case, who has been treated for more than eleven years, takes this amount regularly, and remains free from all symptoms of myxœdema. In some cases seven minims are quite sufficient for the permanent daily dose. I have not found it necessary to give more than ten minims in any case.

In slight cases it is not necessary to confine the patient to the house, and ten minims of the extract may be ordered from the commencement of the treatment. In these cases it is probable that a portion of the thyroid gland still retains its functional activity, so that when the first stage of the treatment is completed the permanent dose for the second stage may be rather smaller than in the advanced cases, where the gland is probably quite functionless. Five or seven minims of the extract each night have proved to be sufficient in some of my cases.

The most striking results of the treatment carried out in the manner just described are seen in advanced cases of myxœdema. In these in the course of from two to six months the symptoms all disappear. The temperature gradually rises to normal, the subcutaneous swelling is gradually removed, and the face resumes its normal expression and appearance. If there has been alopecia the hair grows again. Full strength and energy are regained, and the limbs can once more be freely and actively moved. The mental hebetude is removed, the hallucinations disappear, and actual insanity has in some cases been cured. The total amount of urea in the urine is increased, the red corpuscles increase in number, and if the menopause has not been reached menstruation is re-established. In fact, if no incurable degenerative changes have occurred in the heart or other organ the patient is restored to health.

Exophthalmic Goitre

History.—During the earlier part of last century several cases of what we now know to be exophthalmic goitre were recorded without their true nature being recognised. Graves was the first to describe it as a separate disease in a clinical lecture published in 1835, and in recognition of this the name Graves' disease is often applied to it. Five years later von Basedow gave a more exact description of the symptoms, emphasising the association of the three main symptoms of exophthalmic goitre and palpitation, and in Germany the disease is often named after him. During the last sixty years several hundred papers have been written on the subject, so that the literature is now very considerable.

Etiology.—*Age.*—Exophthalmic goitre is rare in childhood, though it has been observed at the age of two and a half years. It occurs most frequently in adolescents and young adults, more cases developing during the third decade than in any other equal period of life.

Sex.—Women are far more liable to suffer from exophthalmic goitre than men, as there are at least eight times as many cases in women as in men.

Heredity.—In a few instances the disease has been observed in two and even three successive generations. Thus in an example given by Rosenberg, the paternal grandmother, two paternal aunts, the father, and one sister of the patient, all suffered from exophthalmic goitre. Less rarely two or three sisters in a family may show, more or less, marked symptoms of the disease. Three sisters once consulted me at the same time; one had well-marked symptoms, and the other two slight symptoms of Graves' disease. I was informed that the mother and a fourth sister both had goitre, but could not ascertain if other symptoms were present or not. It is not uncommon to find that there is a well-marked tendency among the relations of the patient to suffer from various neuroses, especially epilepsy, chorea, hysteria, and insanity.

Personal Antecedents.—Persons in all classes of life seem to suffer alike. Anæmia, quinsy, and rheumatism, in a considerable number of cases, precede the onset of the disease. In others some prolonged illness, exertion or mental strain appears to have predisposed the patient to the disease.

Exciting Cause.—Of the actual exciting cause of exophthalmic goitre in the great majority of cases we are as yet quite ignorant. In some cases, however, the symptoms have followed soon after some special event which appears to have acted as the exciting cause. This has generally been some severe fright associated with mental or physical shock, or else a prolonged mental strain or emotional disturbance. Thus one of my patients, at the age of twenty-four, fell off a bridge into the water and was nearly drowned; a goitre appeared a few months later, and when I saw her fourteen years afterwards it was still there, and though the eye symptoms had disappeared, the pulse was still 120, and there were tremors of the hands. In another of my cases, a young lady was engaged to be married when her *fiancé* developed phthisis, to which he succumbed a year later. Symptoms of exophthalmic goitre appeared soon afterwards, apparently as a result of this year of anxiety and suspense.

SYMPTOMS.—There are five leading or primary symptoms in exophthalmic goitre, with which may be associated other secondary symptoms.

The chief symptoms are enlargement of the thyroid gland, increased frequency of pulse, exophthalmos, general nervousness, and muscular tremors. Two or three of these symptoms are present in all cases, any one of which may be the first to attract the attention of the patients or the friends. In some cases the exophthalmos is first noticed, or the palpitation gives rise to alarm; in others the goitre is discovered first. In many, however, the nervousness, with irritability and restlessness, is the first obvious sign of ill-health. The several symptoms will now be considered in detail.

The Thyroid Gland.—Some enlargement of the thyroid gland is present in the great majority of cases. The swelling in the neck may be the first sign of the disease, or it may develop at the same time as the exophthalmos and palpitation, while in some cases it is not noticed until after the appearance of these symptoms. As a rule the enlargement takes place gradually during several weeks, but it has been known to come on in a few hours. The amount of enlargement is usually moderate, but readily visible to the eye; in some cases it can, however, only be detected on palpation. The whole gland is uniformly enlarged, and as the right lobe is normally larger than the left, this difference becomes more marked when the gland is hypertrophied. During the earlier stages of the disease the gland gradually enlarges, then for a variable period it remains stationary, or may show slight variations in size from week to week or even from day to day.

In many cases the enlarged gland is seen to pulsate; this movement is often communicated by the violent throbbing of the carotid arteries, though in some cases there is a genuine expansile pulsation of the whole gland. A systolic thrill can be felt in some cases on light palpation, and a systolic murmur can frequently be heard when the stethoscope is applied to the front of the neck.

In the later stages of the disease fibrosis of the enlarged gland may develop, so that it gradually becomes smaller and harder. This is really a beneficial change, and may be accompanied by subsidence of the other symptoms. In some cases, however, this process has gone on to advanced fibrosis with atrophy of the gland, and the symptoms of myxœdema have in consequence replaced those of exophthalmic goitre.

Ocular Symptoms.—Several different ocular symptoms occur either singly or in association, so that it will be convenient to consider them all together, though some might equally well be described along with the nervous symptoms.

Exophthalmos.—This when present is naturally the most conspicuous symptom of all, and consequently is all the more distressing to the patient. It generally comes on gradually, and is present in some 80 per cent of cases. The amount of exophthalmos varies considerably from a slight staring expression to so great prominence of the eyeballs, that the sclerotic is clearly visible both above and below the margin of the cornea, and the eyelids cannot be closed. Sometimes the exophthalmos is more marked on one side than the other, or it may in rare cases be unilateral. In about one-fifth of the cases there is no exophthalmos. Even in the same case the prominence of the eyeball may vary in degree, from time to time, along with the other symptoms. Conjunctivitis is frequently present.

Von Graefe's Symptom.—When this is present there is defective descent of the upper eyelids when the patient looks downwards. Thus when the eyes are kept fixed on the finger during a rapid downward movement the upper lid lags behind, so that the downward rotation of the eyeballs brings the sclerotic within view between the upper lid and the margin of the cornea.

Stellwag's Sign.—In some cases there is retraction of the upper eyelid, due to increased tonic contraction of the elevator of the eyelid. This increases the width of the palpebral fissure already widened by the exophthalmos; it may, however, occur when the latter symptom is absent.

In addition to these symptoms there is sometimes weakness of convergence, so that when the eyes are fixed on an object which is gradually brought closer to them, they at first converge naturally until a point is reached at which they suddenly become parallel again, only one eye remaining fixed on the object. The actual distance at which this occurs varies in different cases, and in the same case at different times.

A general weakness of the external muscles of the eyeball is not uncommon, and there may be diplopia on looking upwards, or downwards, or to the extreme right or left. Sometimes there is actual paralysis of one or more of the muscles. Complete ophthalmoplegia externa with ptosis is rare, though I have one case in a man under observation in which, although the other symptoms of the disease have to a large extent subsided, there is almost complete immobility of the eyeballs with double ptosis.

Vision, as a rule, is unaffected, and the reactions of the pupil are normal.

Circulatory System.—An increase in the frequency of the contractions of the heart is a constant symptom of exophthalmic goitre, in fact the condition of the circulatory system closely resembles that of a man who has just taken violent exercise when out of training, or who is experiencing some powerful emotion.

This increased frequency of the pulse may come on gradually, or may at first occur only for short periods at a time, becoming constant at a later stage. Palpitation is often complained of early, and may be the first symptom noticed by the patient. The pulse-rate may vary from 90 to 100 in mild cases, though in cases of moderate severity it is usually 120. In more severe cases the pulse may be 140 or even 160. The heart is very irritable, so that with slight exertion or excitement the pulse-rate may be increased by 20 or 30 beats a minute. In some cases, even when lying in bed, there are occasional paroxysmal attacks of violent palpitation which come without any apparent reason, during which the skin is generally flushed and perspires freely. During one of these attacks I have counted as many as 200 heart-beats in a minute. The radial pulse is usually regular, but rather small and compressible.

There is generally strong pulsation in the carotid arteries, often in the abdominal aorta, and even in the retinal arteries as well.

The area and force of the cardiac impulse are both increased, and the apex beat, especially in cases of some duration, is frequently in the left nipple line or even outside it. Both heart sounds are loud, and there may be some blurring of the first.

In many cases a soft systolic murmur is audible at the apex, especially when there is dilatation of the left ventricle with secondary mitral incompetence. A soft systolic murmur is also often to be heard at the base. In several of my cases there has been a peculiarly rough, loud systolic murmur over the pulmonary area, so rough in one or two of them as to resemble pericardial friction rather than an endocardial murmur.

Nervous System.—Various nervous symptoms may occur in exophthalmic goitre, general nervousness and tremor being the most common.

General Nervousness and Mental Condition.—In nearly all cases there is a peculiar condition of nervousness. In severe cases this is shown by great restlessness, the patient fidgets about when sitting on a chair, the attitude and the position of the limbs being changed every few seconds. In other less severe cases the restlessness may be less marked, but the patient is agitated by trifling events, such as seeing a stranger, the tremor being exaggerated and the pulse-rate increased. Such patients complain that they are unduly worried by domestic cares, and are apt to be irritable upon very slight provocation with those with whom they live. Not infrequently much time and care is expended upon some trifling object, while there is a lack of power of continuous application to any regular occupation. Though cheerful as a rule, they are liable to fits of depression with crying. In some cases these symptoms become greatly exaggerated and result in actual insanity, which usually takes the form of mania or melancholia.

Tremor.—Tremor is a common symptom which is nearly always present at one time or another during the course of exophthalmic goitre. It is most easily observed when the patient extends the arms and with the palms directed downwards and the fingers spread out. It varies greatly in degree in different cases, and in the same case at different times. When very slight, it may be felt more easily than seen by laying the fingers lightly on the back of the patient's extended hand. This symptom sometimes comes on early, but, as a rule, is not noticed until after the other symptoms already described have attracted attention. The whole limb is affected, but especially the flexors and extensors of the wrists, so that the tremor affects the hand as a whole and not the fingers separately. The tremor also may affect the legs, and even the head and neck. The rhythm is rapid and regular, each complete movement occupying about one-eighth of a second. The range of movement is small but variable. Fine voluntary movements, such as writing, may be impeded, but not prevented by the tremor in some cases. Any extended or unusual effort increases the tremor, which is least marked when the patient is lying down at rest.

Other nervous symptoms, in addition to those already described, have been observed. A sudden giving way of the legs, so that the patient falls to the ground, occurs in some cases. Painful nocturnal cramps of the feet and legs, and even of the hands, have been described by Dr. Hector Mackenzie. Inability to walk, while the legs can be moved when the patient lies down (astasia-abasia), has been recorded by Dr. Maude.

The Skin. — *Pigmentation.* — In many cases there is more or less pigmentation of the skin. This is most marked in those situations in which the skin naturally contains most pigment, and may therefore be similar in distribution to the pigmentation in the earlier stages of Addison's disease. The eyelids and the neck are common situations, as are also the axillæ, the areolæ of the nipples, and the flexor surface of the joints. The face may be uniformly coloured, or there may be brown patches on the cheeks. Pressure, such as that caused by the garter, may also determine a localised increase of pigmentation. In one of my patients all the skin of the face, neck, hands, and fore-arms was pigmented, so that she looked as if she had been working in the sun with her sleeves rolled up to the elbow. The colour of the skin may vary from a yellowish tint to brown, but does not reach the dark brown which is seen in an advanced case of Addison's disease. The mucous membrane of the mouth is not pigmented.

Perspiration.—The skin generally feels warm and moist, and the skin of the face may look rather greasy. In addition to this, profuse local or general sweats and hot flushes are not uncommon, especially in the more acute cases. They may last for an hour or so, and are sometimes repeated two or three times in the day. Profuse general perspiration often accompanies the paroxysmal attacks of palpitation already mentioned. Patients often complain of feeling hot, and seem to feel cold very little. As a result, they not infrequently go about in quite thin clothing in cold weather. They are not liable to catch cold; in fact, in some of my cases this liability appears to have diminished with the onset of exophthalmic goitre. One of my patients, who formerly suffered a good deal from chilblains, told me that they had not returned since the symptoms of exophthalmic goitre developed.

In a considerable number of cases the electrical resistance of the skin has been found to be diminished. This is probably a direct result of the moist condition of the skin, which naturally acts as a better conductor when moist than when dry, and is not peculiar to Graves' disease. Temporary œdematous swellings of the subcutaneous tissues sometimes appear in various parts of the body. Regular œdema of the lower extremities may occur, but it is to be regarded as a complication secondary to anæmia or cardiac failure.

Hair, Nails, Teeth.—Loss of hair frequently occurs in all parts of the body. The head may become completely bald, as in one of my cases in which the eyebrows and eyelashes had completely, and the pubic hair had partly disappeared, and did not return while she was under observation. In another case the hair was also lost during the earlier part of the illness, but grew again later on when the other symptoms improved.

The nails in some cases are thin and brittle, or they may be deeply grooved. Caries of the teeth is not uncommon.

Respiratory System.—The frequency of respiration is increased in a good many cases. In some it is the result of anæmia or of cardiac weakness. It may, however, occur quite independently of either of these causes. The respirations may be as frequent as 30 or 38 in a minute. In one case which I saw with Dr. Messer of Lemington this symptom was the earliest to attract attention, and as it followed an attack of influenza it suggested the onset of some pulmonary complication such as pneumonia. The lungs, however, remained quite healthy, and other symptoms of exophthalmic goitre soon followed. Paroxysmal attacks of coughing occur in some cases, as do also attacks of dyspnœa with cyanosis which may even prove fatal. Profuse bronchorrhœa has been observed in a few cases, and is considered by Bramwell to be analogous to the sweating and diarrhœa to which some patients are liable.

Digestive System.— In a considerable number of cases there is an increased frequency of defæcation. This must be distinguished from diarrhœa, as the motions are solid and normal in character. In these cases the bowels may act two or three times a day. No harm apparently results beyond the inconvenience which it causes. Sudden attacks of diarrhœa are not at all uncommon. As a rule there is no pain, and the motions are loose and copious. Two or three may be passed in a day, and then the attack ceases, or it may continue for two or three days and then terminate as suddenly as it began. Vomiting may be a troublesome symptom, and sometimes is difficult to control. It developed in the case already mentioned with early rapid respiration, and continued until the patient died from exhaustion. Dr. D. Drummond recently drew my attention to a great craving for food which he had observed in some cases, and since then I have seen several cases in which there was a marked increase in the appetite.

Genito-Urinary System.—The urine is normal in the majority of cases; in some, however, the quantity is increased. Intermittent albuminuria is present in some cases, and glycosuria has also frequently been observed. Menstruation is often irregular. Periods of amenorrhœa are not uncommon, while in some cases there is menorrhagia. Pregnancy may occur, and may be accompanied by improvement in the symptoms, though hæmorrhage after delivery may be excessive.

General Symptoms.—Emaciation is present in nearly all well-marked cases of Graves' disease, and is frequently in proportion to the severity of the other symptoms. The actual loss of weight is very considerable in some cases, and may amount to as much as forty pounds in a year, or even to ninety-three pounds in ten months, as in two cases mentioned by Mannheim. Varying degrees of anæmia may often be observed in exophthalmic goitre, though by no means constantly. A slight rise of temperature is not uncommon, and may be persistent, or of only temporary duration, recurring from time to time.

VARIETIES.—All the symptoms of the disease may vary greatly in intensity in different cases. In one exophthalmos may be the most striking symptom, in another the frequency of the pulse, and in another the goitre or the tremors and general nervousness, while the other symptoms are only slightly developed.

A well-marked case is easily recognised, but where one or more of the primary symptoms are slight or absent altogether, the real nature of the case may be overlooked. In the incomplete cases there may be no exophthalmos. In some of these, however, there is a slight widening of the palpebral fissure which gives rise to a startled expression. An increase in the pulse rate is present in all cases. The presence of this symptom alone in a patient without any obvious explanation should always lead to a careful search for other symptoms of Graves' disease, for many cases of so-called "tachycardia" are really incomplete cases of exophthalmic goitre.

The enlargement of the thyroid in some cases is only slight, but in nearly all cases there is some enlargement at the time of the examination, or a clear history of it having been present at an earlier stage.

COURSE, DURATION, AND TERMINATION.—The course of exophthalmic goitre varies very considerably in different cases. There is usually a period of development during which the symptoms appear and gradually increase in severity. This period may vary from a few weeks to several months or a year. After a time the symptoms remain more or less stationary in many cases, with slight temporary variations. This stage may last only a few weeks, or may continue for many months or for several years. After this, in a favourable case, the symptoms gradually decrease in severity. In some they finally disappear altogether, while in others they become so slight that the patient feels practically well again. In these cases, however, a careful examination may still reveal a somewhat frequent pulse, slight enlargement of the thyroid gland, a faint tremor or some general nervousness of which the patient herself is fortunately unaware.

Sometimes the onset is acute, and this may be followed by an acute course and early recovery within two or three months. On the other hand, these acute cases may run a rapid downward course to a fatal termination within a similar period of time.

In the majority of cases the symptoms run a more chronic course, and may persist for years. Four or five years is a not uncommon period for the symptoms to last. In two cases which I saw twelve and thirteen years after the onset, the symptoms were still well marked. In another case, twenty years after the commencement, the pulse was 92, the thyroid gland was normal in size, and there was very slight exophthalmos with slight retraction of the upper eyelids. The patient considered that she had quite recovered from the disease, as she was not conscious of these slight traces of her former condition.

Recovery from exophthalmic goitre may be followed by the development of myxœdema. In these cases the enlarged gland is gradually reduced in size by a progressive fibrosis which is beneficial up to a certain point, and is accompanied by a subsidence of the symptoms of Graves' disease. The fibrosis unfortunately progresses too far, so that the gland is no longer able to supply a sufficient amount of its secretion owing to the atrophy of the glandular epithelium, in consequence of which myxœdema develops.

I have only seen one example of this sequence of events in an interesting case under the care of Dr. Scott Jackson of Alnwick. The symptoms of myxœdema may begin to appear before all those of exophthalmic goitre have quite disappeared, or there may be an interval of good health between them.

In those cases in which an apparent recovery has taken place, as already described, a recrudescence of the symptoms is not uncommon. In one such case I attributed the return of the symptoms to excessive bicycling.

Death may occur from some complication, to which the patient, already exhausted by Graves' disease, can offer but feeble resistance, or from the severity of the disease itself. Cardiac failure is the actual mode of death in some cases, which may thus terminate suddenly and somewhat unexpectedly in a fatal attack of syncope. In other cases all the symptoms become acutely increased in severity, and the patient dies exhausted. Persistent vomiting or diarrhœa has contributed largely to the fatal issue in some cases. Patients with exophthalmic goitre bear operations badly. Several have died after removal of one lobe of the enlarged thyroid gland. Under these circumstances death may occur suddenly within an hour or two of the operation. One of my cases died half an hour after the operation. It is difficult to determine whether the shock of the operation itself or the anæsthetic is the chief source of danger. In some cases death occurs within a few days of the operation, from an acute exacerbation of all the symptoms and consequent exhaustion. This appears to be the result of the absorption of a large amount of thyroidal secretion, which has either escaped into the wound from the cut surface of the gland, or has been driven out of the gland into the blood-stream by pressure exerted on it during the operation, as the symptoms are the same as those of severe thyroidism produced by large doses of thyroid extract.

In operations on other organs also there is a considerable risk of death, as in a case recorded by Mr. J. D. Harris of Exeter, in which a woman aged forty-six, with exophthalmic goitre, died from cardiac failure sixty-eight hours after removal of the left breast under ether.

Diagnosis.—In a well-marked case the presence of the primary symptoms of exophthalmos, enlarged thyroid gland, and frequent pulse with probably tremors, general nervousness and emaciation, at once suggests the diagnosis. In some of the ill-developed varieties which have already been described the diagnosis is more difficult. An important feature, however, is the constant presence of a quick pulse, the presence of which without some obvious cause, such as fever or cardiac disease, should always suggest the possibility of the presence of Graves' disease, and lead to a careful search for other symptoms. In these cases the pulse is always frequent, and thus differs from that of a patient with paroxysmal attacks of tachycardia, whose pulse-rate falls to the normal between the attacks.

In a few cases there may be no obvious enlargement of the thyroid gland; in some of these cases, however, a careful examination reveals the fact that the gland is larger than in health, or there is a history of a previous enlargement which has subsided.

In the absence of exophthalmos and other earlier symptoms the diagnosis is indicated by the cardiac and nervous symptoms. Slight cases with an enlarged thyroid gland can be distinguished from cases of moderate parenchymatous goitre by the fact that the latter are not accompanied by any nervous or cardiac symptoms. It is important, however, to remember that exophthalmic goitre may develop in a patient who has previously had a simple goitre without general symptoms; in such cases the history shows that the goitre has preceded the onset of the other symptoms by a long period of months or even years.

Prognosis.—At the beginning of exophthalmic goitre prognosis is a difficult matter. It is more favourable in women than in men. The circumstances of the patient must also be taken into account, as the prognosis is certainly better in those who can lead a quiet, easy life and have proper attention, than in those who are obliged to work when not really fit to do so, and are unable to afford the many accessories which can make the illness so much more tolerable. In such a prolonged disease the patient is often lost sight of, so that it is difficult to obtain complete records of a series of cases.

Dr. W. M. Ord and Dr. Hector Mackenzie have tabulated 57 cases, including 24 observed by Dr. R. T. Williamson, in which the disease had lasted more than five years or ended fatally. Of these 14 died, 10 recovered completely, and 11 almost completely. In 13 there was considerable, and in 4 slight improvement; 4 remained unaltered, and the remaining patient was alive, but the condition was not known.

Taking slight and severe cases together, from one-third to one-half may be expected either to recover completely or to such an extent that the remaining symptoms are scarcely noticed. About one-quarter of the cases succumb to the disease.

The onset of œdema, dyspnœa, and other signs of cardiac failure, indicate that the patient is in danger, and if they continue to increase in spite of complete rest and treatment the prognosis is very grave.

Repeated vomiting and severe diarrhœa are also serious symptoms, for if they continue, the patient soon dies from exhaustion.

Pathological Anatomy.—There is general emaciation, and but little subcutaneous fat remains. The small amount of fat in the body is in striking contrast to the excess of fat which is often found in the orbit, and which is most probably the cause of the exophthalmos.

Thyroid Gland.—The thyroid gland is uniformly enlarged except in cases of long standing, in which there may be some irregularity in outline owing to the development of fibrosis in some parts of it. The superficial veins are large, and in well-developed cases the arteries are dilated and tortuous. The number of alveoli is increased owing to the enlargement of the gland, and in many of the alveoli the secretory surface is increased by folding of the wall, so that the lumen is diminished and has an irregular outline. The epithelial cells themselves are large and columnar in shape, instead of being flat or cubical as in the normal gland. The secretion seen in the alveoli is smaller in amount, is less viscid, and stains less deeply than in health.

In cases of long duration there may be more or less fibrosis.

Thymus Gland.—The thymus is generally persistent and may be increased in size.

Nervous System.—Various changes have been described in various parts of the nervous system, but none of them are constant or even frequent. Hæmorrhages have been described in the medulla oblongata by Hale White, by Greenfield, and by Grainger Stewart and Gibson. On the other hand, many observers have found no change of any kind in the medulla, and Möbius considers that, as a rule, no lesion is found in this situation.

No changes of importance have been found in either the brain or spinal cord. Some observers have described changes, such as leucocytic infiltration and degeneration of nerve-cells, in the cervical sympathetic ganglia. Similar changes have, however, been found both in healthy subjects and in other diseases, and so have no pathological importance.

The heart may be unaltered. In some cases there may be some dilatation and hypertrophy of the ventricular walls. Valvular lesions are only occasionally found.

PATHOLOGY.—The pathology of exophthalmic goitre is of much interest, and is still a matter for discussion. We shall, however, endeavour to indicate what seems the most probable explanation of the phenomena of the disease in the present state of our knowledge.

We have seen that there is no constant lesion of the nervous system to be found, so that we must look elsewhere for a primary lesion. The most obviously and constantly affected organ is the thyroid gland, and this we believe to be the essential lesion of the disease. Shortly stated, we believe the symptoms to be due to the excessive formation by the thyroid gland of secretion, which may or may not be normal in character, which being carried into the general blood-stream, so acts upon the nervous and circulatory systems as to produce the familiar symptoms of the disease.

In the thyroid gland the structure suggests a great increase in secretory activity, for not only is the gland enlarged as a whole, but the plication of the alveolar wall gives an increased secretory surface, while the individual epithelial cells are also increased in size.

It is evident that these structural changes indicate increased activity, for in the monkey when one lobe of the gland is removed the other undergoes compensating hypertrophy, and similar folding of the alveolar wall associated with increased size of the epithelial cells is found.

In man, large doses of thyroid extract produce a condition known as thyroidism, in which the symptoms are remarkably like those of exophthalmic goitre. The earliest symptom is acceleration of the pulse. The pulse-rate may be increased to 100, 120, or even 130, and the patient often complains of palpitation. There may be slight tremor of the hands, and the skin becomes moist and flushed. If the large doses are continued, emaciation takes place in some cases. In exceptional cases, when such large quantities have been taken as to cause toxic symptoms, fever, diarrhœa, insomnia, restlessness, polyuria, glycosuria, albuminuria, rapid respiration, and even exophthalmos have been observed.

We have already seen that myxœdema is due to loss of thyroidal secretion, so that exophthalmic goitre being due to the opposite condition of excess of secretion, presents also a contrast in symptoms. In the former there is atrophy of the thyroid gland, with increase of weight, dry skin, absence of perspiration, subnormal temperature, placid temper, and slow pulse; in the latter, hypertrophy of the thyroid gland, loss of weight, moist skin, excessive perspiration normal or raised temperature, nervousness, excitability, and quick pulse.

A further point of interest is that exophthalmic goitre may subside and be followed at once or after an interval by myxœdema. The progressive fibrosis of the thyroid gland leads to removal of the symptoms of exophthalmic goitre in the first place, but in its later stages causes thyroidal atrophy and myxœdema. No case has been recorded in which exophthalmic goitre has developed after myxœdema.

These facts all strongly support the theory we have stated above, as the most reasonable explanation of the pathology of the disease.

Treatment.—In exophthalmic goitre, whatever the medicinal treatment may be, the mode of life which the patient is able to adopt is a matter of great importance. We may, therefore, in the first place, consider some general rules of living, which should, as far as possible, be followed in all active cases of Graves' disease. We will consider what is most suitable for a well-developed active case, with moderate goitre, distinct exophthalmos, nervousness, tremors, and a pulse-rate of 120 or more. At the commencement of treatment, in some cases it is a good plan to confine the patient to bed altogether for a fortnight or three weeks; in milder cases this is not necessary. Throughout any course of treatment, at least twelve out of the twenty-four hours should be spent in bed. It is advisable, therefore, for the patient to be in bed by 10 P.M., to breakfast in bed at 9 A.M., and to rise not earlier than 10 A.M. As many of the remaining twelve hours of the day as possible should be spent in the open air. During the summer months in this country eight to ten hours may be spent with advantage out of doors. Even in cold weather outdoor life is well borne, as cases of exophthalmic goitre do not feel the cold and rarely catch cold. Most of the time passed out of doors should be spent lying down on a couch or deck-chair in an open shelter or verandah, much in the same manner as in the outdoor treatment of phthisis. A short walk of a quarter of a mile each morning and afternoon may be taken at first, and the distance gradually increased, as improvement takes place, to a mile or more twice a day. Drives in an open carriage in the country may also be taken several times a week, but the patient should not drive herself. Many of those who suffer from exophthalmic goitre have previously led very active lives, and may at first find this inactivity trying, but it is remarkable how soon they appreciate its advantages. Cases of exophthalmic goitre should not be allowed to walk in a town, or attend public meetings or gatherings of any kind, as such always have a harmful effect upon them. They may, however, with advantage receive a few friends at home, but should always be relieved from any social duties or pleasures which prove in any way irksome.

Reading may be allowed, but the print must not be too small. Music also may help to relieve the monotony of the treatment.

As the course of exophthalmic goitre is often slow and protracted, this quiet life must in some cases be continued for two or three years, or even longer. As a rule, however, marked improvement takes place in the course of one or two years, so that the stringency of the rules laid down may be gradually relaxed. The early months of the year may with advantage be spent on the south coast of England; Hastings, Bournemouth, and the Isle of Wight are suitable places. The health resorts of southern Europe entail a long journey, which is not advisable, at any rate for cases in which the symptoms are active. During the summer and autumn some quiet place in the country or at the seaside should be selected.

Ordinary diet, as a rule, is all that is necessary, but it may with advantage be supplemented by one glass of milk taken at 11 A.M. and another at bedtime.

Local treatment of the goitre should always be carried out and continued for a long period. A piece of the red iodide of mercury ointment about the size of a pea should be rubbed into the skin over the goitre each night till the skin is reddened, and afterwards every other night. In some cases it is better to use the ointment of half the usual strength. On the whole, the most useful drugs are belladonna, convallaria, arsenic, the bromides, and iron if there is anæmia. Tincture of belladonna should be given in doses sufficiently large to produce slight dryness of the mouth and throat; in some of my cases, however, it has proved so disagreeable to the patient that it had to be discontinued. The digitalis group of drugs have but little effect in diminishing the pulse-rate; the most useful member is tincture of convallaria in doses of 5 to 10 minims in cases in which the palpitation is troublesome and the pulse very frequent. When the general nervousness and tremor are excessive the bromides may be given with advantage. In many cases a prolonged course of arsenic in small doses, such as 5 minims of liquor arsenicalis, twice or thrice daily after meals, has greatly improved the condition of the patient. The arsenic may be combined with any of the drugs mentioned, according to the nature of the symptoms present. The thymus gland has been used in many cases; it may be given in five-grain tablets, three to six of which may be taken daily. Opinions differ as to its utility. Dr. Hector Mackenzie has seen no good effects in twenty carefully observed cases. Favourable results have, however, been observed by others; and in one of my cases, who took three dried thymus tablets each day for nine months, the pulse-rate, which varied from 132 to 143, gradually fell to 84, the goitre disappeared entirely, the tremor became much less, and the exophthalmos was diminished. The further course of the case has not been followed, as she ceased coming to the hospital. In other cases improvement has also been observed, but not to such a marked extent.

Sodium phosphate, which may be given in doses of twenty to sixty grains two or three times a day, has been found useful by Trachewsky and by Kocher. The glycerophosphate is preferred by some, and may be given in five or ten grain doses or as the compound syrup.

Certain acute symptoms at times may develop and require special treatment. Severe attacks of palpitation, in which the heart beats 150 to 200 times a minute, should be met by complete rest in bed and the application of an ice-bag to the præcordial area. Persistent vomiting is a serious and in some cases fatal complication; it should be treated by rest in bed and rectal feeding. Morphine is the most useful drug, and may be given by the mouth, or better by hypodermic injection. A quarter of a grain or more of morphine tartrate may be given once or twice a day with or without one-hundredth of a grain of atropine sulphate. In one of my recent cases each injection controlled the vomiting for some hours, but the patient was very nervous, and dreaded the injections so that a morphine suppository was used instead. Dr. Dreschfeld has found large doses of potassium citrate useful, but they had no result in the case just mentioned. Diarrhœa is most easily controlled by dilute sulphuric acid and laudanum.

In cases in which the symptoms are acute, and especially if rapid wasting has taken place, a course of Weir Mitchell treatment, in which isolation, rest, and over-feeding are combined with massage and electricity, proves most beneficial.

Electricity is useful in many cases. The faradic current should be employed in the following manner:—Two electrodes about 4 ins. by 2 ins. are applied to the neck, one behind and the other over the thyroid gland in front, and kept in place by means of a strap on each side. The electrodes are connected with a dry-cell faradic battery, and enough current is turned on to produce a distinct prickling sensation in the skin. The current may be applied for half-an-hour or an hour night and morning.

The true place of surgical treatment for exophthalmic goitre is difficult to determine. We have seen that the symptoms are due to excessive secretion by the thyroid gland, so that removal of one lobe of the gland is quite a rational treatment. A considerable number of cases who have survived the operation have been greatly benefited by it. Unfortunately there is considerable risk in the operation itself. Some patients die just after the operation, either from shock or the effect of the anæsthetic, and in others severe toxic symptoms have developed soon afterwards from absorption of an excessive amount of secretion, which has either escaped into the wound from the cut surface of the gland, or has been squeezed out of the gland during the operation. At present there are but few cases in which an operation is advisable, and even then it should only be undertaken after explaining to the patient the risks which must be incurred, and at a time when no acute symptoms are present.

ACUTE THYROIDITIS

CAUSATION.—Acute inflammation of the thyroid gland is rare and may occur as a primary disease or as the result of injury or secondary infection. Secondary thyroiditis may occur as a complication in rheumatic fever, influenza, enteric fever, and other acute infective diseases.

SYMPTOMS.—The onset of the disease may be rapid and the attack may be ushered in by a rigor. The temperature rapidly rises to 102° or 103° F. At the same time a sensation of fulness or even actual pain may be felt in the front of the neck. The whole gland, or it may be one lobe only, then becomes swollen. In a few severe cases the swelling is large enough to press on the trachea and œsophagus, and cause difficulty in breathing and in swallowing. The inflammation may subside in a few days, and be followed by complete resolution. In a few cases, however, suppuration or gangrene of the gland occurs instead.

TREATMENT.—Rest in bed and a milk diet should be ordered while there is fever. The application of ice or leeches to the front of the neck or the use of belladonna fomentations gives relief to the pain. At the commencement of the attack five grains of calomel or blue pill may be given at night, followed by a saline aperient in the morning. Fifteen or twenty grains of sodium salicylate may be given three times a day. If suppuration occurs the abscess should be incised and drained.

GOITRE

Goitre is a term in general use for all enlargements of the thyroid gland. As the enlargement may be due to several different causes there are several varieties of goitre.

Varieties.—A slight temporary enlargement of the gland occurs in anæmic and in pregnant women, but it is not sufficiently great to be considered as a form of goitre. A general enlargement of the gland occurs in young adults, and may attain a considerable size. This is practically a hypertrophy of the gland, and is known as simple parenchymatous goitre. The endemic form of goitre may commence in a similar manner, but later secondary changes, such as multiple cystic degeneration and fibrosis, may occur, so that very large goitres of this class are seen, composed of varying proportions of glandular tissue, fibrous tissue and cysts, fibro-cystic goitre. Adenoma of the thyroid gland is another common form of goitre. These growths are prone to become cystic, and as a rule a single-cysted goitre is due to the presence of a cystic adenoma in one lobe of the gland. Exophthalmic goitre has already been described, and malignant goitre will be considered separately.

Etiology.—Goitre occurs much more frequently in women in this country than in man. It may occur at any time of life, but most frequently is first noticed about puberty. Goitre is hereditary in some families, though in some cases this may be due to several generations living under similar conditions. One of my cases, a young married woman, who was sent to me by Mr. A. Thompson of Darlington, with a large adenoma of the thyroid, had a twin sister who also had a goitre. In certain districts, which are for the most part mountainous with deep valleys, goitre is endemic. Such districts occur in the Pennine range in England, and especially in the mountainous parts of Switzerland and the adjoining countries. The disease is also endemic in some flat countries, as on the plains of Lombardy and in the Indian Punjab. Of the many local circumstances which have been suspected of causing endemic goitre the drinking-water has proved to be the most important. The disease has developed after the introduction of a fresh water-supply, where it was not endemic before, and conversely, in a previously goitrous district change of water-supply has been followed by a steady diminution in the number of cases. What the active constituent of the water may be is not yet known, but the fact that such water is rendered harmless by boiling indicates that it is possibly a living micro-organism.

Symptoms.—When a goitre is small, a swelling in the thyroidal region, which moves upwards when the patient swallows, and a sense of fulness in the neck, may be the only signs of its presence. The character of the swelling varies according as the goitre is parenchymatous, adenomatous, cystic, or fibro-cystic. In parenchymatous goitre it is uniform in shape and consistence with the normal gland. An adenoma forms a firm rounded mass, and a cyst a smooth globular swelling in which fluctuation may be felt. In some cases, however, it is difficult to determine by palpation whether an adenoma is cystic or not. Dyspnœa is not uncommon, and is generally due to narrowing of the trachea by unilateral or bilateral pressure exerted upon it by the goitre. In other cases pressure may be caused by an extension of the goitre behind the trachea or in front between it and the sternum. Dyspnœa may, but rarely, occur as the result of pressure on the recurrent laryngeal nerves, causing paralysis of the abductors of the vocal cords. In cases of large goitre there may be sudden paroxysmal attacks of dyspnœa, especially at night. Dysphagia may occur, but it is rare. A goitre may undergo rapid enlargement as the result of hæmorrhage or of acute inflammation.

Medical Treatment.—In the early stages of endemic goitre, removal from the goitrous district, or the boiling of all drinking-water, may be followed by the disappearance of the goitre. In simple parenchymatous goitre, especially in young adults, the best results are obtained by giving thyroid extract. In some cases the goitre disappears entirely, in others it is reduced to one-half or a third of its former size, while in some cases little or no effect is produced. From one to three grains of dry thyroid powder should be given twice or thrice daily. This dose may be continued for six or eight weeks. If the goitre is then diminishing in size the treatment may be continued for another two or three months. If there is no decrease in size at the end of the first two months further continuance of the treatment is useless. This treatment may be accompanied by the inunction of red iodide of mercury ointment. Potassium iodide and iodoform have also been successfully used in the medical treatment of goitre.

MALIGNANT DISEASE.—Both carcinoma and sarcoma of the thyroid gland are rare, but clinically it is often difficult to distinguish between them. Carcinoma may originate either from the alveolar epithelium of the gland or from the parathyroid gland. A sarcoma may be either round or spindle-celled.

Malignant disease may develop in a gland which has previously been healthy or in one already goitrous. In carcinoma there is generally rapid enlargement and early fixation of the goitre. The swelling is hard and irregular in shape. There may be radiating pain over the front of the neck. Paralysis of one or both vocal cords is strong, but not conclusive evidence of malignant disease. The trachea, œsophagus, and blood-vessels may be first compressed and later invaded by the growth. The lymphatic glands are only infected after the growth has extended beyond the capsule of the gland. Sarcoma is generally more uniform and softer in consistence than carcinoma and may be cystic.

The only treatment which offers any prospect of success is total removal of the whole thyroid gland as early as possible.

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UNTIL a comparatively quite recent period, operations upon the thyroid gland were looked upon with great suspicion, and were only resorted to when urgent symptoms imperatively called for surgical interference, and as a matter of necessity. This hesitation to interfere surgically with the thyroid gland was due to the fact that death arose so frequently, either immediately from hæmorrhage during the operation, or later on from some form of blood poisoning. Now, however, that both these causes of death have been well-nigh eliminated from operative surgery, the one by the invention of pressure forceps, the other by aseptic surgery and the technique of operations on the thyroid gland brought to great perfection, the thyroid is operated upon very successfully, not only in cases of necessity, but also as a matter of expediency. No operation upon the thyroid, however apparently trifling it may seem to be, should ever, even now, be undertaken without special care, and every precaution being taken to bring it to a successful issue. Apart from the risk of hæmorrhage and sepsis, neither of which contingencies are altogether absent, there are other special dangers both during and after operations upon the thyroid gland which cannot be ignored. The trachea, pharynx, œsophagus, pleura, and the recurrent laryngeal nerve have all been injured during the operation. Death may arise during the operation from the entrance of air into veins, from suffocation, or from syncope. The first accident should not occur, and if every vein be securely tied with double ligatures before it is divided, and great care be taken not to injure the internal jugular vein, there is no danger to be apprehended from the entrance of air into veins. With every possible precaution death may arise during operation from suffocation or from syncope. Myxœdema or tetany has arisen, as a consequence, when the whole of the gland has been removed; and even after tapping a cyst or the enucleation of an adenoma, recurrent hæmorrhage has proved fatal or placed the patient's life in danger. The commonest disease to which the thyroid gland is liable is goitre, that is to say, "an enlargement not due to inflammation nor to malignant disease." Goitre is due either to hypertrophy or to the development in the substance of the gland of adenomatous growths, which may either be solid or cystic, but are generally the latter. These growths are always encapsuled. Hypertrophy of the thyroid, or parenchymatous goitre as it is perhaps more usually, though not more accurately designated, may, though involving both lobes and reaching very large dimensions, give rise to no or to very slight inconvenience, and when this is the case there is no necessity to interfere with the condition surgically. Often, however, the patient experiences, from time to time, some difficulty in breathing. Sometimes this dyspnœa is very severe, comes on suddenly, and endangers life. It has proved fatal very quickly and quite unexpectedly. It may recur from time to time with little or no warning, and so make the patient's position one of great anxiety and distress without ever actually endangering life. The difficulty of breathing may also be continuous and progressive, so as slowly to destroy life by suffocation. That thyroid enlargement of any kind should cause dyspnœa is not to be wondered at when the very intimate connection between the gland and the trachea is borne in mind. The trachea is apt to be pressed upon and flattened from side to side, when both lobes are enlarged and compressed, or displaced to one or other side by enlargement of one lobe only. Whenever the trachea is encroached upon by the pressure of a goitre, it is almost invariably flattened laterally. In those very formidable and fortunately rare cases where an enlargement of the thyroid extends behind the manubrium of the sternum and presses upon the trachea, occasionally but only rarely even in such cases, the flattening is antero-posterior and not lateral. Whether the trachea be flattened or displaced, in either case the breathing is liable to be more or less interfered with. The difficulty in breathing is practically always due to direct pressure, that is to say, unless the trachea be directly pressed upon you very seldom have dyspnœa. The trachea may be displaced to a considerable extent, and little or no inconvenience in breathing ever be experienced. Much depends upon the rapidity with which the enlargement of the thyroid and consequent pressure upon the trachea takes place. The more acute the enlargement the greater is the liability for dyspnœa to arise; and the more chronic the disease the less is it likely to give rise to difficulty in breathing. Bleeding into the substance of a parenchymatous goitre occurs occasionally, and then the enlargement is sudden and great difficulty in breathing arises, so much so as to call for surgical interference to prevent the patient dying from suffocation. Inflammation seldom attacks a goitre of any kind except as a result of traumatism. When inflammation occurs, it is practically always the result of some surgical interference, such as the injection of some fluid into a parenchymatous gland or the tapping of a cyst. The inflammation may readily cause, from a rapid increase in the size of the gland, difficulty in breathing. It may also run on to suppuration. Should suppuration result, the pus must be let out as soon as ever it is detected. An abscess may burst into the trachea and suffocate the patient, or matter may find its way into the cellular tissue of the neck, a very serious condition, and one very difficult to treat with much prospect of success. There are certain periods of life and certain conditions of the body when a goitre is likely to enlarge rapidly.

It is well known that a relation exists between the thyroid gland and the generative organs. Hence at or about the age of puberty an enlargement of a previously small goitre often causes difficulty in breathing. A great number of the parenchymatous goitres operated upon occur in young people at or about the age of puberty. Particularly is this the case with boys, which accounts probably for the number of youths suffering from parenchymatous goitre, who are operated upon for the relief of dyspnœa. During pregnancy, too, and at the menstrual period, women, the subjects of parenchymatous goitre, not infrequently regularly suffer from some difficulty in breathing, owing to an increase in size of the goitre. All goitrous subjects are apt to experience dyspnœa whenever they suffer from catarrh, and often at no other time. Of the medical treatment of goitre it is unnecessary for me to speak. It is the parenchymatous variety which is in any way amenable to medical treatment. Adenoid disease is a surgical affection, and no benefit is likely to be derived from its medical treatment. Various surgical methods have, from time to time, been resorted to for both varieties of goitre. Setons and injections of various kinds have been employed. Ligature of the thyroid arteries, division or removal of the isthmus are still occasionally practised, but extirpation of a part of the gland in parenchymatous enucleation of the growth from the substance of the gland when the disease is due to adenoma are, however, the recognised operations of the present time. No one would now, I suppose, for one moment entertain the idea of treating goitre by means of a seton, though not so very long ago this method was recommended and practised. Sir Felix Semon recommends the injection of from twenty to thirty drops of tincture of iodine into a parenchymatous goitre every third day, and he has given precise directions as to how this treatment should be carried out. The results, however, are not by any means encouraging. Suppuration and death have ensued far too frequently to make this treatment popular. Other fluids, such as tincture of iron, have been injected into a goitre with the view of a cure, but the principle of injection has little to recommend it, and should not be resorted to. Permanent cures are quite exceptional from this method, and the risk is very considerable. Ligature of the thyroid arteries has lately been revived as a cure for certain cases of parenchymatous goitre. At best this is an uncertain means by which to attempt to cure any form of goitre. The supply of blood to the gland is so remarkably free, that unless both the superior and inferior thyroid arteries be tied, a cure can hardly be hoped for. It is not a particularly difficult thing to ligature the superior thyroid vessels, but to do so will not interfere permanently with the size of an enlarged thyroid. If in addition the inferior thyroids be tied, the operation has become a severe and difficult procedure. The inferior thyroids are deeply situated behind the gland, and there is a considerable risk of wounding veins in the attempt to reach and tie them. The operation necessary to tie the four thyroid arteries, or three of them, which has been recommended, is quite as serious a procedure as removal of half the gland, and is not nearly so likely to permanently cure the patient. Simple division of the isthmus has been resorted to in cases of parenchymatous goitre for the purpose of relieving urgent dyspnœa. Temporary relief has usually followed this comparatively simple operation, but with the healing of the wound the difficulty in breathing has recurred. This operation and that of excision of the isthmus have both been resorted to in the belief that the difficulty in breathing was due to pressure of the isthmus on the trachea, but the belief is an erroneous one. If it were true, immediate relief would follow either division or excision of the isthmus, but though relief has in most cases followed both procedures it has not been immediate. It is just in those cases where immediate relief from urgent dyspnœa is imperative that the isthmus will be divided, and as the relief does not follow at once there is not much to be said for the operation. The relief which follows the division or excision of the isthmus for urgent dyspnœa is due, not to the relief from pressure of the isthmus on the trachea, but to drainage from the cut surfaces, causing reduction in the size of the lobes generally, and thus relieving the lateral pressure which is the cause of the difficulty in breathing.

The pressure upon the trachea is not from before backwards, but is almost invariably exerted laterally. This has been demonstrated over and over again, is admitted, and there is no dispute about it. The dyspnœa of goitre is often of a spasmodic nature, suggestive of spasm of the glottis from irritation of the recurrent laryngeal nerve, but it is exceedingly doubtful whether in goitre this ever is the explanation of the difficulty. In malignant disease, where the structures round about the growth are infiltrated, spasm of the glottis from implication of the recurrent laryngeal nerve is by no means uncommon, and indeed is one of the consequences to be looked for. The character of the dyspnœa in malignant disease is quite different from that in goitre. In goitre the difficulty is very generally, almost always tracheal, and there is seldom any difficulty in speaking or aphonia present. In malignant disease the difficulty is often laryngeal, so much so, indeed, that aphonia or dysphonia, in a case of disease of the thyroid, should always make us suspicious of malignancy. Whenever it becomes necessary to interfere surgically with a parenchymatous goitre, the proper operation to be performed is thyroidectomy. It is undesirable to remove the whole of the gland on account of the liability of myxœdema ensuing, but the greater part of both lobes and the isthmus, or one lobe with or without the isthmus, may be excised with very little risk of such a result arising. Myxœdema has, however, followed—and sometimes rapidly—the removal of one lobe only. It may be necessary to operate under urgent circumstances during an attack of dyspnœa; but in the majority of cases the operation is performed during an interval when the danger of suffocation during the operation is very much diminished. The risk of death occurring from suffocation during removal of part of the thyroid is undoubtedly very much increased by the administration of a general anæsthetic. It is best, therefore, particularly in those cases where the breathing is already, at the time of operation, embarrassed, and even in those cases where it is known dyspnœa is likely to arise, not to place the patient under a general anæsthetic. Some local means of blunting sensibility may be resorted to, such as the injection of cocaine into the line of the skin incision shortly before operating. The operation is by no means a particularly painful one, and no hesitation need be felt in performing it without any kind of general anæsthetic, should it be desirable or necessary to do so. The administration of a general anæsthetic has caused death during thyroidectomy on numerous occasions, even when no particular danger was apprehended. Death too has arisen, from the anæsthetic, even before the operation has been commenced, sufficiently often to emphasize the danger of its administration. Thyroidectomy may be a comparatively easy operation, and on the contrary it may turn out to be a most difficult and tedious one, taxing the patience and skill of the surgeon to the utmost. The object of the operation is to relieve dyspnœa, due to direct and nearly always lateral pressure of the enlarged gland upon the trachea, and as this object can be accomplished by removal of one lobe, and at most of part of the other, it is seldom necessary to remove more; and, at any rate, the whole of the gland should not be taken away. If only a small part be left, the risk of myxœdema arising is very much diminished. In performing the operation the most important principle is to gain free access to the parts involved. Some differences of opinion exist among surgeons as to the best skin incision. All agree that it must be a very free one, but upon the direction of the incision there is not quite the same unanimity. Erichsen recommends "an incision in the middle line from the upper border of the tumour to the sternal notch." Kocher, who is certainly the greatest authority upon the surgical treatment of goitre, recommends "a transverse curved incision as the best." Its advantages are, he says, "It falls along the line of cleavage of the skin and gives rise later to an almost imperceptible scar. A transverse curved incision with the concavity dissected upwards is carried across the most prominent part of the swelling, and is prolonged farther upwards and backwards over the sterno-mastoid upon the side on which the disease is most marked. The incision is placed on a higher or lower level, as may be required; in goitre situated low down, quite at the lower part of the neck." Berry, in his exhaustive and excellent treatise on the diseases of the thyroid gland, advocates an oblique incision parallel to the inner margin of the sterno-mastoid. He says, "This is the incision that should be adopted in most cases of extirpation, and in those generally in which the operation is likely to be difficult or dangerous. It gives the operator plenty of room, and enables him to reach the upper horn of the gland without undue difficulty. The lower end of the incision should, in almost all cases, be carried down to the upper border of the sternum, if it be intended to operate upon both lobes of the thyroid, the lower part of the incision being carried well across the middle line at a somewhat higher level than the top of the sternum." Attention should also be drawn to an angular incision which Kocher recommends, "for the sake of those who have less experience." It is commenced over the prominence of the sterno-mastoid at the level of the thyroid cartilage, and extends almost transversely in the direction of the skin creases as far as the middle line of the neck, and from thence vertically downwards to the sternal region. In deeply situated goitres it is prolonged on to the manubrium sterni. Whichever of these incisions is adopted, and there is something to be said in favour of each, according to the size and position of the tumour, the subsequent stages of the operation are much the same. The platysma and fascia are to be divided freely to the same extent as the skin. Any veins in the way must be carefully secured between two catgut ligatures, and divided. If now, by drawing to the outer side the sterno-laryngeal muscles, sufficiently free access can be obtained to the gland, the operation may be completed without dividing any muscles. When this can be done it is an advantage, but unfortunately it is seldom possible. Should there be any difficulty, either owing to the size of the goitre or to its fixation, it is better to divide these muscles and turn them down at once. It may be requisite also to divide, or to partially divide, the sterno-mastoid muscles. It is much better to divide all the muscles than to be cramped by want of room. The capsule of the gland must be thoroughly exposed. It is not to be opened, the object being to remove the gland covered by its capsule. There may be some difficulty in recognising the capsule. It is a very delicate structure. Immediately beneath it large distended thin-walled veins, readily torn, will be seen coursing over the surface of the gland. The next step is to free the gland, covered by its capsule, from surrounding structures. This must be done with great gentleness, care being taken not to tear the capsule, nor any veins, and not to bruise the gland by any rough handling of it. The gland is best separated from its surroundings by means of the forefinger. Then the vessels supplying the gland are to be secured. The superior thyroid arteries with their accompaying veins are usually easily secured. The artery enters the apex of the lobe on its inner border and upon its anterior surface. It is much smaller than the inferior thyroid, and should be tied with a double silk ligature. Sufficient tissue must be left between the two ligatures to render that on the distal side of the tumour secure from slipping when the intervening portion is cut through. Some veins are usually found passing from the middle zone of the lobe to the internal jugular. Under normal conditions of the gland these veins are small and insignificant; but when the thyroid is enlarged from goitre they are often large, and should be carefully sought for, isolated, and tied with double ligatures of silk, the distal ligature being applied as far from the junction with the internal jugular as possible. In securing these veins great care must be taken not to injure the internal jugular vein, which, distended with blood, and sometimes considerably displaced, has from time to time been punctured. The group of veins lying on the trachea, included under the name of inferior thyroid, which empty themselves into the innominate, must be secured and divided between two ligatures. Sometimes a thyroidea ima artery is found also lying on the trachea, passing from the isthmus generally to the arch of the aorta, and may also require to be tied. It should now be possible to dislocate the gland towards the middle line for the purpose of finding and ligaturing the inferior thyroid artery. The inferior thyroid is a much more difficult artery to secure than the superior. It is a much larger vessel, deeply situated and distributed upon the posterior surface of the gland. It is not, as a rule, accompanied by a vein, but occasionally a middle thyroid vein may leave the gland close to the spot at which the inferior thyroid artery or some one or other of its divisions enters the gland. It is best to tie the inferior thyroid artery after it has divided into branches as near as possible to the tumour, and any veins may be secured in the same ligature. The inferior laryngeal nerve has a close but not a constant relation to the inferior thyroid artery, usually lying superficially to the vessel, but sometimes passing beneath it, and occasionally being found among its branches. Great care must be taken not to injure the nerve at this stage of the operation. The isthmus has now to be dealt with. Along its borders run branches of the superior and inferior thyroid arteries, inosculating with those from the opposite lobe. Upon the surface of the isthmus some veins may generally be seen. These vessels should all be ligatured, after which the isthmus may be divided with scissors. In some cases it has been found convenient to divide the isthmus before tying the inferior thyroid artery, more particularly in those where the isthmus is bulky. The only connection now to be dealt with is that between the trachea and the otherwise free lobe which is to be removed. In separating this often tough connection there is often danger of dividing the recurrent laryngeal nerve. During the performance of the somewhat prolonged, it may be, operation of thyroidectomy, every precaution and care must be taken to keep the wound aseptic. No bleeding vessel, however small, artery, or vein, should be left unligatured. All clots must be removed by gentle sponging. If it has been found necessary to divide muscles they must be as accurately as possible sutured with cat-gut. The skin wound should be closed with horse-hair sutures, and it is best to drain the large and somewhat irregular wound by means either of a tube or piece of gauze. Healing should take place very quickly without constitutional symptoms.

ADENOMATOUS TUMOURS.—Adenomata occur commonly in the thyroid gland. They vary considerably in size and number, and one or more may exist in one or both lobes. Occasionally an adenoma is found developed in the substance of the isthmus. They are usually cystic, and then may grow to considerable dimensions. Bland Sutton, in his work on tumours simple and malignant, gives a drawing of one successfully enucleated by T. Burns, which reached as low as the umbilicus. Whether solid or cystic they are always encapsuled, and should, except under very exceptional circumstances, be removed by enucleation. It may be necessary to remove the lobe in which a number of cysts are grouped together, on account of the serious bleeding which would attend an attempt to enucleate them one by one, but enucleation should always be preferred when practicable. Whenever an adenoma, solid or cystic, gives rise to dyspnœa, it should always be removed. Though causing no inconvenience, if they should be considered unsightly, if they be increasing in size, or in order to prevent their becoming the seat of inflammation or of the extravasation of blood into them, which is not so very uncommon an occurrence, particularly in the cystic variety of the disease, they should either be enucleated or left alone. A cystic goitre should not be tapped. To enucleate an adenoma, whether cystic or solid, the capsule of the thyroid gland must be exposed much in the same way as when a part of a lobe is about to be excised. In enucleation the capsule of the thyroid and the thyroid tissue lying over the adenoma have to be divided. Before doing this, however, any veins on the surface of the thyroid, in the line of incision, should be tied with double silk ligature and divided. Then the superjacent thyroid tissue must be cut through till the capsule of the tumour is reached. By means of the forefinger the whole surface of the capsule of the growth must be carefully, but as quickly as possible freed from the thyroid tissue in which it is embedded. This is the stage of the operation at which, not infrequently, very free and sometimes alarming bleeding takes place. As soon as the growth is enucleated every bleeding vessel must, as rapidly as possible, be secured and tied with silk. The interior of the cavity left in the thyroid by the enucleation of the growth must be quite dry and free from clots before it is closed. It is better to drain the wound by means of a little gauze. Union should take place by first intention, and the scar should be almost imperceptible.

GRAVES' DISEASE.—The pathology of Graves' disease is not at present thoroughly understood. The condition has been most successfully dealt with by physicians. Although it is probable no case has been actually wholly cured, the condition of the patients suffering from Graves' disease has been much improved by medical treatment, and the progress of the disease has undoubtedly, in numerous instances, been permanently arrested. The surgical treatment of Graves' disease has not been nearly so successful. According to the views entertained by the surgeon as to the pathology of the affection, various operations have been performed. The superior cervical ganglion has been removed, the sympathetic nerve has been divided, and both sympathetics have been dissected out from the neck and removed together with their ganglia on the supposition that the condition might be due to disease of the sympathetic nerves. No sufficiently satisfactory results have followed any of these operations to warrant their repetition. Kocher has tied the thyroid arteries for cure of Graves' disease a number of times, but again the permanent results have not been satisfactory. No case has been actually cured by either of these procedures. A portion of the thyroid, generally one lobe, has been removed a good many times on the theory that Graves' disease was due to functional over-activity of the thyroid gland. Some of these patients are reported to have been completely cured, others to have benefited, and a large proportion to have died during the operation, or a very few hours after. Stars, who has published some statistics on the results of cases of Graves' disease treated by excision of a part of the thyroid, says, "Death after these operations is not due to hæmorrhage, nor to any want of antiseptic precautions. In all the cases reported there has been a sudden rise of temperature to 105°, 106°, 107°, a very rapid pulse (180 to 200), extreme nervous excitement and restlessness with great anxiety and distress, profuse sweating, and finally collapse and death from heart failure." There is considerable difference of opinion among surgeons who have experience of this method of treating Graves' disease as to its efficacy, and on the whole the balance of opinion is against it, or any other surgical interference.

MALIGNANT DISEASE OF THE THYROID, whether carcinoma or sarcoma, is fortunately a very rare disease. It is seldom met with in patients younger than forty years, and there are no means by which with any certainty a sarcoma can be distinguished from a carcinoma. Malignant disease of the thyroid is a most unsatisfactory condition to treat surgically, the mortality arising directly from operation being very high and immunity from a recurrence being very short. The nature of the disease can seldom be diagnosed early enough for the patient to be operated upon with much prospect of success. Clinically, malignant disease is met with in two stages. In the earlier the growth is confined within the capsule of the gland, and there are no signs by which it can, in this stage, be distinguished from a non-malignant disease. Later on, when the growth has extended beyond the boundaries of the capsule and is infiltrating neighbouring structures, the growth is apt to become irregular in outline, and it will be fixed, grow fast, and give rise to a considerable amount of pain. The trachea is often invaded by a prolongation of growth into it, the carotid sheaths become infiltrated and fixed to the growth. The recurrent laryngeal nerve, too, is pressed upon and is apt to become embedded in the rapidly increasing growth, and in consequence speech becomes difficult; the voice is altered in character, and spasm of the glottis may give rise to alarming attacks of difficulty in breathing, any one of which may destroy the patient. Sometimes, too, there is difficulty in swallowing. These symptoms make, at this stage of the disease, diagnosis easy, but unfortunately it is quite hopeless to interfere with a view of curing the patient by a removal of the disease. It is only while the growth is confined within the capsule that there is any chance of removing it successfully, and even then the prospect is a very forlorn one. Sometimes malignant disease of the thyroid runs a very acute course. Berry mentions two cases which terminated fatally—one in three, the other in four months after the first appearance of the growth. They were both males, aged 60 and 25 years respectively.

TRACHEOTOMY IN THYROID DISEASE.—In certain cases of thyroid disease where death is imminent from difficulty in breathing, tracheotomy may be the only means of affording the immediate relief which is necessary in order that life may be prolonged. The necessity for tracheotomy is most likely to arise in cases of malignant disease of the gland. Should the case be one where the urgent symptoms are due to pressure upon and displacement of the trachea by a simple growth or parenchymatous goitre, the proper treatment is either enucleation or excision. Tracheotomy should never be resorted to if it can be avoided. If for any good and sufficient reason it should be found impracticable, even in cases of non-malignant disease, to remove a swelling pressing injuriously upon the trachea, then tracheotomy might have to be resorted to as the only expedient possible. The difficulties and risks of the operation may be found to be very great indeed. The veins of the neck are often, in malignant disease, for which the operation is most likely to be called for, large and distended with blood. There may be great difficulty in reaching the trachea, either because it is embedded in the growth, or displaced and perhaps altered in shape, or it may be both embedded and displaced to a considerable extent, rendering the operation one of enormous difficulty. The trachea may be displaced to the outside of the carotid artery. The high operation should be performed; usually no other is practicable, and it may be found necessary to cut through growth to get into the trachea. Having opened the trachea, it will usually be found that the ordinary tracheotomy tube is not long enough to reach sufficiently low to relieve the difficulty in breathing, and that a special tube must be used for the relief of dyspnœa in malignant diseases of the thyroid. The relief gained has usually been only very temporary, and life has been prolonged for but a short time.

Tinea. *See* SKIN, PARASITES OF.

Tinnitus Aurium.

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THIS symptom, described by patients as buzzing, singing, or ringing in the ears or head, is especially common in diseases of the ear, giving rise to defective hearing, but it may be associated with perfectly normal hearing, and in rare instances with abnormally heightened auditory acuity.

The noises are in general termed "subjective," inasmuch as there is no objective cause for them outside the individual, and, accurately speaking, a distinction should theoretically be drawn between entotic or periotic and purely subjective noises which arise from irritation of the auditory nerve or centres by disturbances which would not in themselves produce sound, or, in other words, by stimuli which are not sonorous. Such would be the sensations of sound arising from fluxional or inflammatory disturbances of nutrition in the labyrinth, auditory nerve, or auditory centres. On the other hand the pulsations in the arteries of the ear, the muscle sounds, and the crepitations and cracklings accompanying middle ear catarrh, are in themselves sonorous, and the sound perceived by the patient is the result of sonorous vibrations in the structures of the ear, and therefore sometimes differentiated as entotic. The distinction, though interesting, cannot always be drawn, and it is of theoretical rather than practical value. With regard, however, to entotic noises, they become audible when an obstructed condition is present which shuts in the sound, and when clinically there is increased bone-conduction for the tuning-fork.

Noises in the head are sometimes classified according to their characters and according to patients' descriptions. These are unlimited in number—chirping, hissing, rustling of leaves, boiling of kettles, rushing of water, rumbling of carts, ringing of bells, escape of gas, blowing-off steam, "telegraph wires," Æolian harp, clicking, pumping, musical notes, voices singing, voices talking, sometimes intelligibly sometimes not.

These noises may be divided into two groups, the "elaborate" and the "simple," the former including such sounds as distinct melodies or voices uttering intelligible words. These may be pure "auditory hallucinations," arising in the brain itself, or they may be "auditory illusions," as when there are simple sound sensations, such as humming or hissing, excited by disease of the ear, but interpreted by the diseased brain as music or speech.

Simple sounds may take various forms, but they may be divided into two great groups, pulsating and continuous.

Pulsating sounds may be taken to be arterial in origin, and we have to endeavour to decide whether the arterial congestion giving rise to them is in the external or middle ear, or in the labyrinth; in the former case they are checked by compression of the common carotid artery in the neck by the well-known method; when produced in the labyrinth they are checked by the less well-known method of compressing the vertebral arteries in the suboccipital triangle; for this purpose the observer presses a thumb and middle finger into the depressions behind and slightly below the mastoid process, formed by the recti and oblique muscles, while counter-pressure is made with the other hand on the patient's forehead. It will be remembered that the labyrinth is supplied by the internal auditory artery, which is a branch of the basilar, and that the basilar is formed by the junction of the two vertebral arteries. Such sounds are sometimes audible to the auscultator, and when they are heard through the bones of the skull and accompanied by giddiness, optic neuritis, and other evidences of intracranial tumour, there is great probability that the tumour is an aneurysm.

Continuous simple sounds may be divided, in the first place, into high-pitched and low-pitched. The continuous tones of a low-pitched character, humming and rushing, are generally venous in origin, and may arise either from passive congestion (as from pressure of a bronchocele or other growth on the jugular vein, or disease of the right side of the heart); others, again, are the muscle sounds, namely, the contraction of the tensor tympani, and these latter are believed to produce the sea-shell noise which some patients are conscious as resembling the sound heard when a sea-shell is held to the ear. This includes also the humming noises which occur in the subjects of anæmia. A curious "clicking" sound, audible often to the observer as well as the patient, is sometimes produced by "clonic" spasms of the tensor palati and tensor tympani. High-pitched tones are usually due to some stimulation of the labyrinth, as when from increased tension of the tympanic apparatus more or less intermittent pressure is exercised on it by the stapes driven into the fenestra ovalis. It also occurs in disease of the labyrinth itself, whether idiopathic, congestive, inflammatory, or degenerative, or resulting from injuries to the head.

Diagnosis of the Cause of Tinnitus Aurium.—In any given case it is more important to be able to diagnose the cause, and this depends as a rule upon other factors rather than the character of the sound.

It is, in the first instance, necessary to determine whether it depends on some disease of the structures of the ear or upon disturbance in the central nervous system due to local or constitutional conditions. We must decide, in the first place, whether there is an associated abnormality of hearing-power. If the hearing-power is diminished we are entitled to assume that the tinnitus and the dulness of hearing arise from the same cause, and we must decide the form of disease which gives rise to the defect of hearing power, whether situated in the auditory centres, the internal, external, or middle ear, and it is upon this that the choice of treatment to be adopted depends. The methods of making these distinctions have been set forth in preceding articles, notably in the writer's (Dundas Grant) chapter on disease of the auditory nerve and labyrinth, vol. i. of this work.

Given that there is a defect of hearing and the noise is simple, the tinnitus is due to disease of the organ of hearing. Should the simple noise be pulsating in character, and if it can be checked by compression of the carotid artery in the neck, it is due to arterial congestion of the external or middle ear, but if by compression of the vertebral arteries in the sub-occipital triangles it is then due to arterial congestion of the internal ear, which it is to be remembered is often of nervous or vaso-motor origin. The tinnitus produced by quinine and salicylates is probably of this nature. It may arise, however, from any cause which increases the arterial tension, notably, more particularly chronic cirrhotic disease of the kidney and vascular disturbance associated with the menopause. Should the pulsating murmur be readily heard on auscultation of the cranium or ear, search must be made for the other signs of intracranial aneurysm.

Should the noise be not pulsating, a high-pitched hissing or singing sound is probably due to increased tension of the tympanic structures, leading to pressure on the labyrinth, or, on the other hand, it may arise from disease of the labyrinth itself. In the former case the tuning-fork tests, probable alleviation on inflation, and the examination of the tympanum, will enable us to make a diagnosis. In the latter case the diminution of bone conduction will, among other tuning-fork tests, enable us to decide that the disease is situated in the internal ear. A low-pitched, dull, rumbling, buzzing, or rushing noise, made worse by lying down, the ingestion of food, or stimulants, or constipation, indicates venous congestion. On the other hand, if it is relieved by lying down, by taking food or stimulants, and accompanied by pallor, it is due to anæmia. It may be noted that the inhalation of nitrite of amyl increases tinnitus when congestive, but diminishes it when anæmic. If along with dulness of hearing the tinnitus is of an elaborated character, such as melodies, or still more voices of people talking, the patient may be said to be suffering from auditory illusions, the elaborated character being due to the misinterpretation of the simple sounds induced by the aural disease.

Instead of being defective the hearing-power in some cases is abnormally acute, owing to increased excitability of the auditory nerve or centres, usually associated with neurasthenic conditions. This peculiarity is often overlooked, and the sounds of which the patient is conscious are usually those produced by the circulation and other movements in the structures surrounding the auditory organs.

There remain a certain number of cases in which the tinnitus is unaccompanied by any abnormality of hearing (tinnitus nervosa), and is therefore not attributable to disease of the ear itself, but to some disturbing agent irritating the central auditory nervous structures, and which may be in the form of gross lesions such as new growths, or of the more minute changes in the brain which give rise to mental disease. The tinnitus may be either simple or elaborate in character, the latter being the auditory hallucinations usually associated with insanity. The "Æolian harp" sounds have been found to depend on the irritation of the tympanic membrane by one of the hairs of the external meatus.

Treatment of Tinnitus Aurium.—It has been shown that in most cases this symptom is due to disease of the auditory apparatus, and the treatment to be selected is in the first instance that suitable for whatever auditory disease may be present. The external anditory meatus will have to be freed from masses of cerumen or desquamated epidermis. An indrawn membrane and narrowed Eustachian tube indicate the necessity for restoring the ventilation of the tympanum by inflation or dilatation of the tube, and the freeing of the naso-pharyngeal and nasal passages. In acute inflammatory conditions with arterial congestion of the middle or external ear, depletion by means of leeches on the tragus or incisions into the turbinated bodies may be called for, while derivation to the intestines and the administration of such a sedative as bromide of potassium in full doses is carried out. If the various tests indicate that the exciting cause is situated in the internal ear, we vary our treatment according as it is congestive or anæmic in character. In the former case we should in general administer bromide of potassium, and deplete through the intestines by means of calomel or salines or hydrobromic acid. Pilocarpine is also useful in these cases, having apparently the power of diminishing congestion of the internal ear. If the tinnitus is due to the administration of such drugs as quinine and salicylates, they must be at once withheld. Attention should be particularly paid to the condition of the kidneys and heart, and improvement will sometimes follow the limitation of the diet to milk and fish, with the avoidance of animal food, at all events in any great quantity. Temporary relief may often be obtained by compression of the vertebrals in the suboccipital region by means of the fingers or of two conical pads placed in the hollows already described, and kept in position by a strap going round the forehead. In tinnitus due to venous congestion any conditions leading to pressure on the veins or difficulty in the return of blood to the right side of the heart should be removed. The excision of enlarged glands in the neck, the reduction of a bronchocele, and the regulation of the cardiac circulation by means of digitalis or strophanthus, must be kept in view. In case of auditory illusion which, as before said, is a misinterpretation of the simple sounds produced by aural or central disturbance, it is most important to attend to the local condition, as successful treatment of this may greatly help in combating the symptoms of insanity which may be present. If the noises are of an elaborate character and hearing is normal in every respect, treatment is more appropriately relegated to the alienist than to the aurist.

If the hearing is abnormally acute (hyperakusis oxyakoia) we have to counteract the neurasthenia, and to select specially those remedies which, while tending to relieve the neurasthenic condition, diminish the acuity of the auditory nerve. Of the latter bromide of potassium is a good type, but quinine is also possessed of such properties that small doses of this remedy have, in the author's experience, appeared at the same time to diminish the sensibility to sounds produced in the surroundings of the ears, and at the same time to give a slight fillip to the nervous system. In any given ease it is difficult to say beforehand how it is going to act, but the writer believes that when the patient finds the sound of his own voice unpleasantly loud (apart from abnormal dilatation of the Eustachian tube), and when the condition of the internal ear is one of anæmia rather than congestion, the quinine is most appropriate; it may be given in doses of ½ to 2 grs., and it is wise to combine with it 10 or 15 drops of dilute hydrobromic acid.

Tinnitus nervosa has been found in some cases to yield to the continuous galvanic current. The positive pole is applied to the ear by means of a moistened pad, and a current of from two to four milliampères is allowed to run for about ten minutes at a time, sudden interruptions being carefully avoided. Mental and bodily rest are often indispensable.

Tongue.

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Development.—The tongue is developed in relation to the mandibular or first branchial arch and the adjacent cleft. According to His the mesoblast becomes thickened and leads to fusion of the arches and grooves in the front of the neck, whereby the "meso-branchial area" is formed. From the portion of the meso-branchial area which lies behind the lower jaw a projection grows towards the mouth, and constitutes the *tuberculum impar,* which by extending forward ultimately becomes that portion of the tongue which lies in front of the circumvallate papillæ. The base of the tongue and the epiglottis are derived from a second prominence which develops behind and below the tuberculum impar. The lateral portions of this prominence grow forward in a forked manner and enclose the tuberculum with which they ultimately become fused. The line of fusion is consequently V-shaped, and its position is marked in the fully-developed tongue by the circumvallate papillæ. At the angle of this "lingual V" is a small pit or depression, rarely more than one c.m. in depth—the *foramen cæcum*—which represents the upper end of a peculiar strand of embryonic tissue which connects the tongue with the thyroid gland. This strand of tissue is known as the *thyro-glossal tract,* and it extends from the foramen cæcum through the substance of the tongue in the raphé between the genio-hyo-glossi muscles, passing in front of the hyoid bone and thyro-hyoid ligament to the pyramidal lobe of the thyroid gland.

Anatomy.—The tongue is essentially a muscular organ, and the fibres of which it is composed interlace in a highly complicated manner. Posteriorly it is attached to the hyoid bone; anteriorly, through the medium of the genio-glossus muscle, to the lower jaw. It is covered with stratified epithelium which in some respects resembles that of the skin, and in others corresponds to the covering of a mucous membrane. On the base of the tongue, behind the circumvallate papillæ, is a mass of lymphadenoid tissue—the *lingual tonsil.*

The tongue receives its vascular supply chiefly through the lingual artery and its branches. Small twigs from the facial and ascending pharyngeal arteries also enter the tongue. The blood is returned by a freely communicating plexus of veins into the internal jugular, external jugular, and anterior jugular veins.

The study of the *lymphatic system* of the tongue is of great surgical importance in relation to the question of glandular infection in cancer. The lymphatic circulation in the organ is particularly free, and the communications with the cervical glands very numerous. As any or all of the groups of glands beneath the jaw and in the neck may be infected in cancer, it is necessary to refer briefly to their arrangement. The *submental* glands, two or three in number, lie in the connective tissue beneath the chin, and receive lymph from the tip of the tongue and the region of the frenum. The efferent channels lead to the submaxillary glands. The *submaxillary glands* occupy the digastric triangle. Some are adherent to the sheath of the submaxillary salivary gland, and some lie in its substance. These glands drain the whole of the front half of the tongue, and are very frequently involved in cases of cancer. The *cervical glands* which lie along the line of the internal jugular vein and carotid arteries ultimately receive nearly all the lymph from the tongue, and are consequently those most commonly infected by malignant disease. The large gland which lies at the bifurcation of the common carotid is usually one of the first and most palpably enlarged glands. The *parotid* and *mastoid* lymphatic glands may also be implicated in cancer, but this is comparatively rare.

Nerves of the Tongue.—The muscles of the tongue are supplied by the *hypoglossal* nerve. The *lingual* nerve is the nerve of common sensation and of taste to the anterior two-thirds of the tongue. The *chorda tympani* branch of the facial is also a nerve of taste. The *glosso-pharyngeal* supplies the posterior third of the tongue with sensation and taste. Its communication with Jacobson's nerve may explain the pain in the ear which so frequently accompanies cancer of the base of the tongue. The *superior laryngeal nerve* sends fibres to the base of the tongue and epiglottis, hence the frequency with which disease in this position gives rise to reflex cough, hiccough, and vomiting. This connection may also explain how spasm of the glottis and pharynx may be caused by sudden depression of the base of the tongue. On the other hand, the excitation of the respiratory movements when the tongue is forcibly drawn upon may be due to stimulation of the respiratory centre through this nerve (Laborde); obstinate hiccough, too, has been relieved by traction on the tongue (Lépine).

Salivary Glands.—The salivary glands—particularly the sublingual and submaxillary glands—lie in close relationship to the tongue, and often share in its diseases. (See "SALIVARY GLANDS," vol. x.)

INJURIES OF THE TONGUE

Lacerated wounds of the tongue most freqently result from a bite, as for example, when a child falls and strikes the chin, the tongue at the moment being protruded between the teeth. During an epileptic fit also the patient may bite his tongue. *Punctured* wounds are less common. They may be produced by a pipe stem, a displaced tooth, or a sharp fragment of a fractured jaw being driven into the tongue. Bullets occasionally lodge in the tongue. Clean cut *incised* wounds are very rare.

When the wound merely implicates the anterior portion of the tongue the bleeding is seldom serious except in hæmophylics. Wounds of the posterior part of the tongue, on the other hand, particularly when they penetrate deeply into the substance of the organ, may give rise to free hæmorrhage. If septic complications ensue secondary hæmorrhage may prove troublesome and even dangerous on account of the difficulty of securing the bleeding vessel amongst the soft, disintegrated tissue. This risk is greatest when a foreign body, *e.g.*, a bullet or a piece of pipe-stem, remains embedded in the tongue.

Treatment.—Primary hæmorrhage should be arrested at once, the patient being anæsthetised for the purpose if necessary. In wounds near the tip of the tongue, after the clots have been removed, the bleeding can usually be controlled by bringing the edges together with stitches. When the wound is situated far back and passes deeply into the substance of the tongue the bleeding point must be secured by a ligature, and to enable this to be done it may be necessary to enlarge the wound. Ligature of the lingual artery in its continuity is seldom called for in cases of primary hæmorrhage, but may be necessary for secondary hæmorrhage on account of the friability of the tissues rendering it difficult to apply forceps or a ligature to the bleeding point.

Septic complications seldom arise if an antiseptic mouth wash, such as weak Condy's fluid or boracic acid, is frequently used. Punctured wounds should be carefully examined lest a foreign body be left embedded. In some cases such an object as a bullet, a needle, or a portion of a pipe-stem, has remained embedded in the substance of the tongue for many months, and has given rise to a firm, indolent swelling closely simulating a solid tumour. Serious hæmorrhage may accompany the attempt to remove the foreign body in such cases.

Scalds of the tongue frequently occur in children from sucking the spout of a tea-pot or kettle. The pharynx is usually scalded at the same time. The tongue becomes swollen and painful, and if the posterior part is implicated respiration may be interfered with. The injury to the tongue seldom calls for more active treatment than the administration of ice, and the use of an anodyne and astringent mouth wash.

INFLAMMATORY AFFECTIONS OF THE TONGUE

Inflammation may affect the whole thickness of the tongue—*parenchymatous glossitis;* or only its covering epithelium—*superficial glossitis.*

PARENCHYMATOUS GLOSSITIS

Acute Parenchymatous Glossitis.—This condition, in which the whole substance of the tongue becomes acutely inflamed and œdematous, is comparatively rare. From the records of reported cases it would appear that young adult males suffer more frequently than others. From the fact that the condition occurs oftener during the winter months it has been assumed that exposure to cold and damp is at least a predisposing factor, and the history of the patient usually bears this out. The infection may follow an acute infectious disease, such as erysipelas or scarlet fever. The determining cause is doubtless an organismal infection by one or other of the numerous forms of bacteria which exist in the mouth. Different forms of the disease—the streptococcal and the staphylococcal for example—are recognised according to the nature of the more active organisms present.

In the *streptococcal variety* the whole tongue becomes swollen and œdematous, and the inflammation tends to spread to the tissues of the neck, setting up that form of acute cellulitis known as "angina Ludovici." The inflammation does not usually go on to suppuration. In the *staphylococcal* variety, on the other hand, the inflammation tends to remain localised to the tongue or even to one part of it, and is liable to end in the formation of a circumscribed abscess.

Clinical Features.—The most prominent symptoms are severe pain and general swelling of the tongue, and these usually come on suddenly. Mastication, swallowing, and speech are seriously interfered with, and there is profuse salivation. In the course of twenty-four or forty-eight hours the tongue may completely fill the mouth and even protrude beyond the teeth. When the swelling is extreme respiration may be so impeded as to necessitate tracheotomy. The submaxillary, salivary, and lymphatic glands are enlarged and tender. As a rule resolution takes place in three or four days, but in the staphylococcal form of the disease a localised abscess usually situated between the genio-hyo-glossi muscles may form.

Treatment.—A sharp purgative should be administered in the first instance, and the mouth should be washed out frequently with an antiseptic lotion. Leeches may be applied to the submaxillary region with a view to diminishing the congestion. When the swelling is interfering with respiration or deglutition several longitudinal incisions should be made into the substance of the tongue. In this way the œdema and congestion are usually rapidly relieved.

Acute Parenchymatous Hemi-glossitis.—In a considerable number of cases the acute inflammation is confined to one side of the tongue, and affects particularly the anterior part. In the centre of the inflamed area a firm nodule is usually to be felt deep in the substance of the organ. The clinical features are the same in kind as those of the condition last described, but the general constitutional effects are less severe, and there is less interference with swallowing and breathing. The inflammation usually subsides without going on to suppuration. The treatment is carried out on the same lines as for acute glossitis affecting the whole tongue.

Mercurial Glossitis.—An acute form of inflammation of the tongue was formerly common amongst those who worked in mercury, and in patients undergoing a mercurial course of treatment for syphilis. Owing to the care now taken in factories where mercury is used, and the greater discrimination employed in prescribing this drug medicinally, this disease is very rarely met with. It differs clinically from ordinary acute parenchymatous glossitis chiefly in that there is much more profuse salivation and extreme fœtor of the breath. It is accompanied also by sponginess of the gums, looseness of the teeth, and other signs of mercurial stomatitis. The *treatment* consists in preventing the further ingestion of mercury, and in employing an antiseptic and astringent mouth wash, such as Condy's fluid, alum, or chlorate of potash.

Gangrene of a portion of the tongue—usually the anterior portion—may result from any form of acute glossitis, or from the spread of cancrum oris from the cheek or gums. It has also followed crushing or laceration of the organ by forceps used to pull out the tongue during anæsthesia. In addition to the use of ordinary mouth washes, frequent washing with peroxide of hydrogen (ten volumes strength) has been found very useful in keeping the mouth sweet. As soon as a line of demarcation forms the slough should be clipped away with scissors.

Glosso-anthrax.—In a few rare cases the tongue has been directly inoculated with anthrax. In addition to the ordinary signs of acute glossitis the characteristic black slough and ring of pustules are present. The condition is almost invariably fatal.

Actinomycosis may also be mentioned as one of the very rare infectious diseases met with in the tongue.

SUPERFICIAL GLOSSITIS

ACUTE SUPERFICIAL GLOSSITIS.—Various forms of inflammation originating in the superficial epithelium of the tongue are met with. As a rule the whole of the buccal mucous membrane is implicated, and the inflammation of the tongue is therefore only part of a general stomatitis (see "STOMATITIS," vol. xi. p. 457).

CHRONIC SUPERFICIAL GLOSSITIS.—The term *wandering rash* has been applied by Barker to a comparatively rare affection of the tongue usually met with in children. It consists in the appearance on the dorsum of the tongue of several smooth, red patches, which soon spread and form oval or circular rings with a more or less yellow margin. The fusion and intersecting of these variegated rings gives to the tongue a peculiar appearance, which, on account of its resemblance to the markings on a map, has led to the term "geographical tongue" being applied to it. There are seldom any subjective symptoms. The exact nature of the disease is as yet undetermined. It runs a very slow course, and is but little amenable to any form of treatment, local or constitutional.

Dyspeptic Tongue.—In certain cases of dyspepsia, particularly of gouty origin, the tongue becomes red, raw, and excoriated, and the superficial layers are the seat of a chronic inflammation. The epidermis is destroyed in patches, and the bare surfaces are tender when touched, or when hot or irritating food comes in contact with them. The relief of the dyspepsia is speedily followed by recovery of the tongue condition.

Leukoplakia or Leukokeratosis.—By far the most important form of chronic superficial glossitis is that known as leukoplakia or leukokeratosis. Much of its clinical importance lies in the fact that it is frequently followed by the development of epithelioma in the tongue. The disease consists in an overgrowth of the horny layer of the epithelium covering the organ, with disappearance of the normal papillæ, whereby smooth, bluish white patches are formed on the dorsum of the tongue. The submucous tissue is infiltrated with leucocytes. The white patches, which are best seen when the tongue is dried, have the appearance of being covered by a thin pellicle, which is soft and pliable and firmly adherent to the surface.

The disease is almost invariably met with in males, and may occur at any age between twenty and sixty. Gout, rheumatism, and syphilis appear to be predisposing factors, and any form of irritation—for example, the chewing or smoking of tobacco, the drinking of raw spirits, the friction of a rough tooth or an ill-fitting tooth-plate—tends to produce the condition.

The milder forms give rise to no discomfort, but when the condition is advanced the patient complains of dryness and hardness of the tongue, with impairment of the sense of taste, and in some cases persistent thirst. If the hygiene of the mouth be neglected cracks and fissures may develop, and the patient has then pain on taking hot or spiced food.

Unfortunately treatment is of little avail in most cases, and the condition, even if it disappears for a time, is very liable to recur. Eventually an epitheliomatous tumour may develop in relation to one of the patches or cracks. The tumour may take the form of a nodule in the substance of the tongue, or of a wart or ulcer on its surface.

All sources of irritation, such as chewing tobacco or smoking, should be removed, and an antiseptic mouth wash used regularly. Alkaline washes, such as a solution of bicarbonate of soda, chlorate of potash, or borax, are particularly useful. Butlin highly recommends the application of ointments, for example, vaseline, lanoline, or cold cream, with eucalyptus, borax, or some other mild antiseptic added. The tongue is first dried, and then covered with the ointment, which the patient rubs into the part by rolling the tongue against the roof of the mouth. This should be repeated night and morning. The application of salicylic or lactic acid may be useful in removing the excess of epithelium. Caustics are to be rigorously avoided, as they only cause irritation, and so tend to favour the development of epithelioma. Constitutional treatment has little or no effect on the leukoplakia, even if the patient is syphilitic. Patients suffering from leukoplakia should be kept under observation for long periods, with a view to the early recognition of malignant disease should it supervene.

The "*smoker's patch*" is the name applied to a small, oval area on the dorsum of the tongue, from which the papillæ have been removed as a result of excessive smoking. The patch is slightly raised, smooth, and red, and may be covered with a yellowish brown or yellowish white crust. It causes no pain or discomfort unless the crust is removed and the raw sensitive surface exposed. If the patient persists in smoking the condition may spread all over the tongue and mucous membrane of the cheeks, and may assume the characters of leukoplakia. The treatment consists in stopping smoking, painting the patches with chromic acid, tannic acid, or alum, and using an alkaline mouth wash.

As a result of chronic superficial glossitis the whole tongue may become perfectly smooth from loss of its papillæ ("*smooth tongue*"), or cracks and fissures of various kinds may appear on its surface. *Eruptions*, comparable to those met with on the skin, in herpes, lichen, eczema, or psoriasis, are also met with on the tongue.

TUBERCULOUS DISEASE.—The tongue is very rarely the primary seat of tuberculosis. In the great majority of cases in which it is affected the patient suffers from advanced pulmonary or laryngeal phthisis, and the tongue is infected by bacilli from the sputum entering some crack or fissure produced—for example, by a ragged tooth. Less frequently the disease spreads by direct continuity of tissue from a patch of lupus on the face or nose.

Clinically the condition may be met with either as a tubercle nodule in the substance of the tongue, or as an ulcer.

In the *nodular* form a lump, seldom larger than a hazel nut, appears on the side or tip of the tongue. At first this swelling has a thin covering of epithelium, and is firm and painless. In course of time, however, caseation takes place, the nodule softens, the epithelium gives way, and tuberculous débris escapes, leaving an open sore. This sore may take the form of a short, narrow, deep fissure, with thickened, overhanging edges, which ultimately caseate and break down and leave a tuberculous ulcer. Less frequently the epithelium around the fissure is raised into folds, and gives to the nodule a papillomatous appearance.

Before the nodule breaks it is liable to be mistaken for a syphilitic gumma, while after the fissure has formed it may simulate a cancerous ulcer.

The treatment of these forms of tuberculous disease is to excise a V-shaped segment of the tongue, cutting wide of the disease. The edges of the wound are then united with sutures, and as a rule primary union occurs if the mouth be kept sweet by the frequent use of an antiseptic wash.

The *ulcerative form* is that most frequently met with clinically. It is usually merely a further stage of the nodular form, the ulcer having been produced by the caseation and breaking down of a nodule in the tongue.

The surface of the ulcer is uneven, pale, and flabby, and is covered with a yellowish grey layer of coagulated mucus, with here and there feeble granulations showing through. The edges are sharply defined, sinuous in outline, and as a rule show little or no induration. Around the ulcer there may be seen several small miliary tubercle nodules, and the tissues of the tongue are usually swollen. The ulcers vary greatly in depth, in some cases being quite superficial, in others eating deeply into the muscular substance of the tongue. The tip of the tongue may be completely eaten away, so that it looks as if it had been cut across with a knife.

At first there may be comparatively little pain, but as the disease advances the pain becomes severe, and there is profuse salivation. The submaxillary glands are usually, but not always, enlarged.

The diagnosis is, as a rule, rendered easy by the presence of other evidence of tuberculous infection. When no such evidence is forthcoming it is extremely difficult to distinguish between tuberculous and tertiary syphilitic and cancerous ulcers. A microscopic examination of a portion cut out from the edge of the ulcer may be of some help, particularly in regard to malignant disease. The effects of treatment by iodide of potassium and mercury are not to be relied upon for diagnostic purposes.

The prognosis is on the whole very unfavourable in view of the frequency with which the patient suffers from other advanced tuberculous lesions. The ulcer may, under suitable treatment, improve, or even heal, but it is very liable to break down again.

Treatment.—Primary ulcers should be treated in the same way as tuberculous nodules—by excising a V-shaped portion of the tongue. Even in cases where other tuberculous lesions are present the operation is often justifiable for the relief of pain and to enable the patient to take nourishment. The wound in the tongue must be accurately sutured, and every possible effort made to secure primary union, otherwise the raw surface may become reinfected from the sputum. When operation is impracticable it is only possible to palliate the symptoms by attending to the hygiene of the mouth, and removing all sources of irritation. Pain may be relieved by the application of ointment containing cocaine or morphia.

SYPHILITIC AFFECTIONS OF THE TONGUE.—Syphilitic affections of the tongue are exceedingly common, and the disease may show itself in so many forms that, as Butlin says, "there is hardly any affection of the tongue in which the possibility of syphilis should not be taken into account in making the diagnosis."

The *primary sore* of syphilis is very seldom met with on the tongue in this country. The most common sources of infection are tobacco pipes, the blow-pipes of glass blowers, and similar implements, and spoons, forks, or drinking cups which have been used by syphilitic persons. Direct infection may, of course, occur from kissing. The sore presents the same general characters on the tongue as on other parts of the body. The submaxillary lymphatic glands are markedly enlarged on one or on both sides. The generalised secondary manifestations of syphilis usually appear early when infection takes place on the tongue.

The local *secondary* manifestation most frequently met with on the tongue is the *mucous patch.* This is very common, particularly in the later periods of the secondary stage. Mucous patches may appear on any part of the tongue, but are most common on its edges, where they form smooth, irregular, greyish white areas of a rounded or oval outline.

If the thin white layer be removed a smooth red surface is exposed. When situated on the under surface of the tongue the patches frequently assume a condylomatous or warty appearance. If they are irritated by the teeth or by the passage of food over them, they may become cracked, or even deeply ulcerated. As the secretion from mucous patches is highly contagious the patient should always be warned of the danger of using spoons, cups, pipes, or other articles, in common with those with whom he lives or works. Kissing must also be avoided.

If left untreated the surface of a mucous patch may break down and leave a tortuous or stellate fissure or ulcer which tends slowly to increase in width and depth. The edges are punched out and undermined, the base raw, sloughy, and devoid of granulations, and the sore is exceedingly tender. After healing, these sores leave puckered scars of a silvery or leaden hue.

In addition to the ordinary constitutional treatment by mercury, the mucous patch may be dusted with a powder composed of equal parts of calomel, boracic acid, and starch, or painted with silver nitrate. Butlin strongly recommends painting the affected part with a 10 per cent solution of chromic acid every two or three days. Irritating food, alcohol, and smoking should be avoided.

The *tertiary* manifestations of syphilis in the tongue are "tertiary plaques" or "sclerosing glossitis," gummata, and ulcers.

Sclerosing Glossitis.—This term was applied by Fournier to a condition in which, as a result of cellular hyperplasia, patches of the tongue become infiltrated with leucocytes, and smooth plaques or tuberous masses are formed on the surface of the organ. These patches appear chiefly on the dorsum, and at first only involve the more superficial strata of the tongue. They tend to be oval in outline, are elevated beyond the level of the mucous membrane, and present a dull red mammillated or lobulated appearance comparable to the surface of a cirrhotic liver. They are firm and elastic, and are insensitive. The neighbouring lymphatic glands are not enlarged. If untreated they tend to break down and form superficial ulcers which heal readily. The process of healing, however, is attended with excessive cicatricial contraction, with the result that deep clefts and furrows are formed, and the tongue is permanently disfigured. In its typical form the disease is very characteristic, and is not likely to be mistaken for any other affection of the tongue. The presence of other evidence of syphilis and the speedy improvement which follows antisyphilitic treatment prevent it being confused with epithelioma.

Gummata may appear on the tongue at any time during the tertiary stage of syphilis. They are usually situated on the dorsum, and more frequently towards the centre than at the edges. As they seldom implicate the floor of the mouth or the base of the tongue, the tongue can usually be freely protruded. It is necessary to distinguish between a gumma which has not broken down on the surface and one which has ulcerated. An unbroken gumma forms an indolent, firm swelling in the substance of the tongue, devoid of pain, and seldom accompanied by enlargement of the adjacent lymphatic glands. After breaking down it forms a deep excavated ulcer, which is often extremely painful and tender, and the glands are usually enlarged.

Two forms of gummata are met with—the superficial and the deep or parenchymatous.

Superficial gummata are almost always multiple, and appear as small, hard nodules in the mucous and submucous tissue, projecting on the dorsum of the tongue. They vary in size from a pin's head to a pea and are quite painless. The mucous membrane over the swellings may retain its papillæ or may be quite smooth. These gummata tend to break down early, forming extensive superficial ulcers.

The *deep or parenchymatous* gummata may be single or multiple. They may appear on any part of the tongue, but are most common on the dorsum. They are met with both in the middle and at the margins of the organ. As a result of congenital syphilis they are occasionally met with in children. The swellings vary in size from a hazel nut to a walnut, and form hard lumps, usually deeply placed in the substance of the tongue. The overlying mucous membrane is of normal colour, but has usually lost its papillæ. Sooner or later, if untreated, the gumma approaches the surface, and after softening breaks down, leaving a deep ragged ulcer, with a foul sloughy surface and firm raised edges. The edges, however, are seldom indurated and everted like those of a cancerous ulcer.

The differential diagnosis of these gummatous swellings is often very difficult. They have to be distinguished, on the one hand, from innocent tumours, such as fatty or fibrous tumours, and on the other from carcinoma. The main points characteristic of innocent tumours are that they are seldom multiple, they are well defined, and movable in the substance of the tongue. Carcinoma is almost invariably single, is usually situated near the margin of the tongue, and generally occurs in patients over forty years of age.

Syphilitic Ulcers and Fissures.—These are almost invariably the result of the breaking down of a gumma. The ulcers are characterised by having a ragged and sloughy base, on the surface of which is a yellowish grey slough, aptly compared in appearance to a piece of wash-leather. The edges are steep, ragged, and often undermined, but they want the typically indurated and everted character of those of a cancerous ulcer. The surrounding parts of the tongue are thickened and firm. The neighbouring glands are not necessarily enlarged. The ulcer is extremely painful when irritated by food, hot fluids, or spirits. If untreated the sore may remain indolent for months, and show no sign either of spreading or of healing, but it may at any time take on the characters of a malignant ulcer.

Syphilitic fissures are met with as long, narrow, deep clefts, or as stellate or sinuous cracks in the substance of the tongue. After the healing of these ulcers and fissures permanent clefts and tumours remain in the tongue.

Treatment.—The tertiary manifestations of syphilis in the tongue are treated on the same general lines as other tertiary lesions. Iodide of potassium, with or without mercury, is given in large doses, beginning with 10 or 15 grains three times in the day, and increasing to 25 or 30 grains. Locally an antiseptic mouth wash, such as chlorate of potash, Condy's fluid, or black wash diluted with lime water, is used. Mercurial ointment may be applied with benefit. If the pain is severe a powder containing iodoform, borax, and a small quantity of morphia may be insufflated. Orthoform is also useful in relieving the pain. Before any of these local applications are used the sore must be thoroughly cleaned and dried. Irritating foods and fluids should be avoided, and any irregularities in the teeth must be attended to. When the diagnosis is doubtful and speedy improvement does not follow these measures, the question of excision of the tongue must be considered.

TUMOURS OF THE TONGUE

The tongue is very frequently the seat of malignant tumours. Innocent tumours and cysts are comparatively rare.

CARCINOMA

As carcinoma is not only the most common, but also the most serious form of tumour met with in the tongue, and as it is often difficult to diagnose it from certain of the lingual affections which have just been described, it is convenient to consider it first. The tumour is nearly always of the squamous celled or epitheliomatous variety. In the latest edition of their work on *Diseases of the Tongue,* Butlin and Spencer state that "glandular carcinoma has occurred in the submaxillary gland, but from the mucous glands on the surface of the tongue no instance seems to have been seen." Since this work was published the present writer has reported, in conjunction with Dr. T. Shennan, a case in which the disease began in the mucous glands.

Epithelioma.—Statistics vary as to the relative frequency with which the sexes suffer, but they appear to indicate that about six males suffer to one female. So far as the writer's experience goes these figures exaggerate the frequency with which epithelioma of the tongue occurs in women. The age at which the disease appears is usually from forty to sixty, but it has been met with as early as twenty in patients of both sexes. In these young subjects the growth of the tumour is rapid, the glands are early and extensively invaded, and the tendency to recurrence after operation is great.

The actual *cause* of the disease is still uncertain, but there is good ground to believe that any long-continued irritation of the tongue, such as is produced, for example, by the rubbing of a jagged tooth or an ill-fitting tooth-plate, is a potent predisposing factor. The evil influence of tobacco smoke appears to have been exaggerated, but there is no doubt that the friction of the rough end of a clay pipe against the tongue is conducive to the development of cancer. Chronic superficial glossitis (leukoplakia), syphilitic fissures and scars, and chronic ulcers, are frequently present for some time before an epithelioma appears, and they seem to play some part in its causation. Butlin expresses himself strongly to the effect that the repeated application of strong caustics to chronic inflammatory conditions of the tongue is a most important, and by no means uncommon, determining cause of cancer.

As regards the *development* of the tumour, it may first appear in the form of an indolent excoriation, ulcer, or fissure, as a warty growth—particularly in association with a patch of leukoplakia—or less frequently as a distinct hard nodule beneath the surface of the tongue. In whichever of these ways the growth makes its appearance it passes through a stage—the so-called *precancerous stage*—in which inflammatory changes, such as infiltration with leucocytes, superficial ulceration, and certain changes in the epithelium of the nature of hypertrophy, or the formation of warty projections, alone are present. These conditions gradually give place to those characteristic of the epitheliomatous tumour, and ulceration soon begins. When the ulcer has formed, its base and the surrounding parts become characteristically hard and indurated, and the adjacent lymphatic glands soon become infected.

Clinical Features.—The tumour is usually situated on the anterior half of the tongue, and is more frequently on the edge than on the dorsum or under aspect. The clinical appearances vary widely. Sometimes the surface of the tumour is covered with a warty growth, sometimes it is excavated, forming a deep ulcer with raised nodular edges. In other cases the ulcer is smooth and its edges even and rounded. Extreme hardness of the edges and of the base of the ulcer is always a characteristic feature. Another characteristic feature is the fixation of the tongue, which prevents it being protruded beyond the teeth. This is especially marked when a growth starting on the edge of the tongue spreads towards the floor of the mouth and invades the lower jaw. There is constant gnawing pain in the tongue, and severe spasmodic pains shooting towards the ear and along the branches of the fifth nerve. In the more advanced stages of the disease there is profuse salivation, and the saliva may be tinged with blood. Owing to the fixation of the tongue the patient has difficulty in swallowing the saliva, and it continuously dribbles from the mouth. The speech is thick and indistinct, owing to the difficulty in moving the tongue. The breath is usually extremely fœtid.

Enlargement and hardness of the adjacent lymphatic glands is always an early sign in cancer of the tongue. The particular group of glands first to become infected depends largely on the position of the primary growth. When the tumour is near the tip of the tongue, or in relation to the frenum and adjacent part of the floor of the mouth, the submental glands are the first to become enlarged. Later the submaxillary group follow suit. When the tumour is farther back on the tongue the submaxillary glands are first implicated, and later those along the line of the carotid artery and internal jugular vein. Owing to the close proximity of the sublingual and submaxillary salivary glands, and the fact that lymphatic glands frequently lie inside their capsules, these glands are often infected. The enlarged glands on the neck are very liable to become cystic, or to suppurate and burst to the surface, leaving unhealthy sinuses or malignant ulcers.

Metastasis to the liver, lungs, or other internal viscera may take place, but is rare. The patient usually dies in from twelve to eighteen months from repeated small hæmorrhages, or from marasmus, septic absorption, or a low form of pneumonia.

Glandular Carcinoma.—As the writer's case of carcinoma of the tongue originating in the mucous glands appears to be the only example hitherto recorded, it may be briefly described. The patient was a sailor, æt. 59, who, save for three attacks of yellow fever, had always enjoyed good health. He denied having had syphilis. About five years before coming under observation he noticed on the dorsum of his tongue a small white patch, which was hard, but not painful. For two years it slowly increased in size, and later began to cause pain. For a year before seeking advice he had had gradually increasing difficulty in moving his tongue in mastication, deglutition, and articulation, until eventually it became almost fixed. During the same period the pain had greatly increased, till it was constant and severe, shooting into the ears and through the head. He had lost a stone and a half in weight in about two years.

On examining the mouth it was found to be filled up almost completely by the tongue, which was thickly coated with a greyish brown fur. There was a large ulcerated area on the right side of the tongue covered by a grey slough. The jaws remained slightly apart, but were almost fixed, and the tongue could not be protruded even to the level of the teeth. Articulation was very indistinct, and he could swallow only with difficulty. There were several large, hard glands behind the angle of the jaw on the right side, and another in the line of the vessels. On the left side only one small gland could be detected.

The tongue was excised by Whitehead's method, but recurrence took place, and the patient died seven months after the removal of the tongue. On post-mortem examination it was found that there were numerous glandular swellings on both sides of the neck, some of which had undergone cystic degeneration. In addition metastatic tumours were found in the lungs, the suprarenal glands, and the pancreas.

Differential Diagnosis.—Cancer of the tongue has to be diagnosed from syphilitic and tuberculous affections, warty growths, and simple ulcers and fissures; and in connection with the differential diagnosis it has to be borne in mind that any of these conditions may take on malignant characters and develop into an epithelioma. In many cases it is impossible from the clinical evidence to arrive at a definite diagnosis, and it becomes necessary to remove a portion of the growth for microscopic examination. Should any doubt still remain the condition should be treated as if it were malignant.

Treatment.—From the point of view of treatment cases of cancer of the tongue may be divided into two classes: (1) those in which there is a reasonable prospect that the disease may be completely eradicated by free removal of the primary growth and of the infected lymphatics, and (2) those in which the disease has extended so widely that complete removal cannot be hoped for.

In the first class the operation should always be recommended as the only line of treatment which offers any hope of permanent cure. The treatment of early cases by the repeated application of caustics cannot be too strongly condemned. Not only does it fail to arrest the growth of the tumour, but the irritation caused by the agent applied actually hastens its spread.

Even in cases where recurrence takes place the operation is usually justified, as it prolongs the patient's life by six or eight months, and by removing the foul ulcerated mass from the mouth adds greatly to his comfort. Further, the recurrence usually takes place in the glands, and is not attended with great suffering. Metastasis to distant organs is rare in cancer of the tongue, and the possibility of its occurrence seldom influences the question of operative interference.

In the second class—where there is little hope of being able to extirpate the disease—the surgeon often has great difficulty in deciding as to whether or not the attempt should be made. Speaking generally, it may be said that if the local disease in the mouth can be completely removed, this should be done, even if the affected glands cannot all be excised. The patient's suffering is almost entirely due to the ulcerated tumour in the mouth causing agonising pain, profuse salivation, and extreme fœtor of the breath, and even if the operation does nothing more than free him of this, and so render his last days bearable, it is amply justified.

If, however, the disease is situated near the base of the tongue, and has spread extensively in the floor of the mouth, on to the tonsils, the palate, or the lower jaw, or towards the opening of the larynx, and at the same time there is wide-spread infection of glands, the operation is seldom advisable. Not only is it attended with serious immediate risk, as the patient is usually very much run down, but rapid local recurrence with persistence of the symptoms renders it futile.

In such cases *palliative treatment* alone is available. The mouth must be kept as sweet as possible by the frequent use of an antiseptic mouth wash, such as Condy's fluid, sanitas, izal, or peroxide of hydrogen. The pain may be relieved to some extent by local applications, such as cocaine or orthoform, but as a rule the free administration of morphia is called for. When feasible, division of the lingual nerve may be performed, but the benefit is seldom great. Hæmorrhage, if slight, may be arrested by local styptics, such as adrenaline or turpentine; if more copious, by ligature of the external carotid in the neck. Tracheotomy may be called for when the respiration is impeded. When the taking of food by the mouth causes much pain recourse must be had to rectal feeding.

Operative Treatment.—Numerous operations have been devised for the removal of the tongue, and in selecting that most suitable to a given case, consideration must be had to the site and extent of the tumour, and the degree of implication of the lymphatic glands.

The chief *immediate risks* of the operation are shock, hæmorrhage, and interference with respiration by the entrance of blood into the air passages.

In patients who are not already exhausted by the disease, who are not suffering from albuminuria, or any other general affection, and who have not been addicted to alcohol, the shock is seldom severe. By adopting the usual measures it can be reduced to a minimum (see "SHOCK").

The prevention of hæmorrhage is one of the most important points in the operation. Some surgeons advocate a preliminary ligature of one or both lingual arteries in the neck as a routine measure. Others only carry this out when an incision has to be made in the neck in any case for the removal of infected glands. In a recent series of cases the writer has found the application of a *temporary ligature* to the external carotid just below the origin of the lingual of great service in diminishing the loss of blood. This measure is particularly useful in cases where extensive operations are called for, as the hæmorrhage from the facial and its branches as well as from the lingual, is controlled. The carotid is exposed in the removal of the infected glands, and a broad catgut or kangaroo-tendon ligature applied as the first, that is the double, twist of a "surgeon's knot." As this loop is tightened the wall of the artery is infolded by the lateral pressure of the finger-nail, so that the lumen is occluded without risk of rupturing the tunica intima.

The subsequent removal of the ligature is facilitated by the simple manœuvre of including in its grasp a piece of stout silk laid parallel with the artery. The ends of the ligature and of the included piece of silk are brought out through the wound. After the operation on the tongue is completed the knot on the ligature is undone by pulling upon the two ends of the silk. This obviates the necessity of handling the wound in the neck after the fingers have been soiled in the mouth.

The risk of blood entering the air passages and causing asphyxia can usually be reduced to a minimum if the patient's head be so placed that the blood tends to flow out of the mouth, and if the back of the pharynx be frequently sponged during the operation. This sponging should be done very gently and no oftener than is necessary, as rough handling of the back of the pharynx appears to add to the shock.

When it is necessary to encroach on the base of the tongue, and when the tumour fills the mouth, it may be advisable to perform a preliminary laryngotomy or tracheotomy. The back of the pharynx can then be firmly plugged while the anæsthetic is administered through the tracheal tube.

The most important of the *remote risks* of the operation is septic infection. It is impossible to lay too much stress upon the importance of thoroughly purifying the mouth before the operation. For several days the mouth should be washed out every two or three hours with an antiseptic wash; the teeth should be cleansed and the ulcer on the tongue purified and dusted with iodoform or some other antiseptic powder. After the operation a special nurse should be detailed to attend to the purification of the mouth and the feeding of the patient. By constant douching and by careful feeding the mouth may be kept perfectly sweet, and the risk of septic complications reduced to a minimum.

Watson-Cheyne recommends the preliminary injection of antistreptococcus serum in cases where there is reason to anticipate septic complications.

Treatment of Infected Glands.—Until within recent years it was generally accepted that operative interference was contra-indicated when there was any considerable infection of the submaxillary and cervical glands, and particularly when the enlarged glands had become fixed. It has been shown, however, that much can be done in the way of removing these glands even when they have formed adhesions to the carotid sheath and its contents. As a rule, it is only the jugular vein which is seriously implicated in the adhesions, and a considerable portion of this vessel may with safety be removed along with the glands if necessary. Cheyne has deliberately removed a portion of the vagus nerve along with a cancerous gland with no further ill effect than a temporary acceleration of the pulse. The writer has had a similar experience.

It is only necessary to remove glands which are enlarged, and the attempt need not be made to clear out the lymphatic vessels between the primary tumour and the infected glands. When there are no glands palpably enlarged Cheyne recommends that the surgeon should rest content in the first instance with the removal of the primary disease in the mouth, and be prepared to deal with any glandular enlargement which may appear later. Butlin and Jacobson, on the other hand, urge the advisability of removing the glands in every case as a matter of routine. "The operation should be performed as soon as the patient has recovered sufficiently from the operation within the mouth to bear it" (Butlin).

Methods of Operating.—It is only necessary to describe three of the numerous methods of excising the tongue—Whitehead's, Syme's, and Kocher's.

Whitehead's Operation.—This method is specially useful in cases of cancer limited to one side of the anterior portion of the tongue, but it may be employed even when the whole tongue is implicated. The mouth is opened widely with a gag, and a loop of stout silk is passed through the substance of the tongue on each side of the middle line, to enable the organ to be pulled well out of the mouth. This loop should be introduced as far back in the tongue as possible so that, when traction is put upon it, the base of the tongue will be brought forward. The mucous membrane is divided with scissors along the middle line, first on the dorsal and then on the under aspect of the tongue, and the muscular substance is torn through. The mucous membrane and muscles of the floor of the mouth are next snipped through with scissors, the vessels being caught with forceps as they are divided. The anterior pillar of the fauces is next divided, and the tongue can then be pulled well out of the mouth by means of the silk sutures passed through it. The operation is completed by cutting transversely across the affected half of the tongue well beyond the tumour. The mucous membrane should first be divided with a knife or scissors and the muscular fibres then torn through. The lingual artery can usually be recognised and clamped before being cut. If it bleeds it is easily secured.

The operation for removal of the whole tongue is carried out on the same lines as for removal of one-half, save that the organ is not split along the middle line.

When the disease invades the floor of the mouth the sublingual gland should be removed along with the tongue.

In some cases there is difficulty in withdrawing the tongue from the mouth on account of its fixation in the region of the anterior pillar of the fauces, and in order to gain access it may be necessary to split the cheek from the angle of the mouth back to the anterior edge of the masseter. Langenbeck advised in addition division of the jaw just behind the molar teeth in such cases. When the tumour is adherent to the jaw it is necessary to remove a portion of the bone.

Syme's Operation.—This operation is suited to cases in which the whole tongue with the structures in the floor of the mouth must be removed. It consists in carrying an incision in the middle line through the lower lip, across the chin, and down to the hyoid bone. One of the central incisors is extracted and the lower jaw divided. The writer has found Gigli's saw very useful for this purpose. The tongue is then separated from the jaw by dividing the muscles inserted into the genial tubercles. The two halves of the jaw are then forcibly retracted in order to expose the floor of the mouth, and to give free access to the tongue. The further steps of the operation are similar to those of Whitehead's operation, the tongue being removed by cutting with scissors wide of the disease in every direction. After removal of the diseased tissues the jaw is wired and the soft parts brought together with stitches. The stump of the tongue must be secured with a strong silk suture to prevent it falling back and obstructing the air passages.

Kocher's operation is also suited to cases in which the whole tongue, right down to the hyoid bone, has to be removed. A preliminary tracheotomy is performed. A curved incision is made from just below the symphysis menti down to the hyoid bone, and then onwards along the line of the digastric muscle and anterior edge of the sterno-mastoid as far as the lobule of the ear. The integument is reflected up over the jaw, and the submaxillary and anterior triangles clear of lymphatic glands. The mylohyoid muscle and mucous membrane are then divided, and the cavity of the mouth thus opened. The anterior pillars of the fauces are next divided through the mouth, and the tongue can then be pulled out through the wound in the neck. The tongue and other diseased tissues in the floor of the mouth are cut out with scissors, the blood-vessels being secured as they are cut.

After Treatment.—After removal of the diseased parts the hæmorrhage is arrested, and the whole of the raw surface may be painted over with a solution of chloride of zinc, forty grains to the ounce. A few catgut stitches may be inserted into the mucous membrane, where possible, to diminish the extent of the raw surface. Care must be taken not to attempt too much in this direction lest the discharge be retained and septic absorption result. It is best to trust to frequent douching and sponging with antiseptic lotions to keep the mouth dry and sweet. For this purpose the writer has found nothing better than Condy's fluid. The patient should be fed as soon as possible after the operation. When there is pain or difficulty in swallowing rectal feeding may be employed for a day or two, but the sooner the patient gets food in the ordinary way the better The food should be administered through a rubber tube attached to the spout of a feeding-cup, and passed well back into the pharynx. After each diet the mouth must be thoroughly douched to remove any fragments of putrescible material.

The purification of the mouth is greatly facilitated if the patient can sit up in bed. This posture is also advantageous in warding off septic lung complications, by preventing the discharges gravitating towards the air passages. As soon as the effects of the anæsthetic have passed off, therefore, he should be propped up in bed with pillows. The patient is usually able to be on the sofa in five or six days, and is practically well by the end of three weeks.

SARCOMA

The tongue is very seldom the seat of sarcoma. When this form of tumour occurs it is usually of the lympho-sarcomatous type, and corresponds to similar growths met with in the tonsils. The small round celled form also occurs. The tumour may begin either in the muscular substance of the tongue or in the submucous tissue. Both forms tend eventually to fungate through the mucous membrane. The diagnosis is always difficult, and is seldom certain before removal and examination of the tumour. In all suspicious cases full removal of the tumour and the portion of the tongue in which it grows is to be recommended. Some tumours show little tendency to recur after removal, while others are extremely malignant.

INNOCENT TUMOURS

Innocent tumours of the tongue are rare. The only forms that call for mention are lipoma, fibroma, angioma, and papilloma.

Lipomata usually occur in males beyond the age of sixty. They may be single or multiple, localised or diffuse. They are of slow growth, soft or semifluctuating, and present the same lobulated character as do fatty tumours in other situations. In many cases a diagnosis can only be made after exposing the growth by an incision. The treatment consists in shelling out the tumour.

Fibromata are met with at all ages, but are most frequently seen in adults. They usually occur on the dorsum of the tongue, and are not unfrequently multiple. They may become pedunculated, particularly when they originate in the submucous tissue. As the growth is made up largely of cellular tissue it is soft to the touch and simulates a lipoma, or even a cystic swelling. It only causes inconvenience by its size, filling the mouth and interfering with speaking and eating. The treatment consists in removing the growth.

Angiomata.—Several varieties of angiomata are met with on the tongue, the most common being the capillary and venous nævi. As a rule the tumour is small, affecting only a part of one side of the tongue and giving rise to no trouble. In rarer cases it implicates a considerable area of the tongue, and by its size interferes with speaking and eating. It is also liable to be injured by the teeth, and so give rise to hæmorrhage and septic complications.

Small growths which are causing no trouble may safely be left alone. If situated on the edge of the tongue, and liable to cause bleeding by being bitten, a small wedge-shaped portion of the tongue, including the nævus, should be excised. Extensive nævi may call for excision of the portion of the tongue implicated. As the operation is likely to be attended with copious bleeding, preliminary ligature of the linguals or temporary occlusion of the external carotids should be employed.

Papillomata, or warty growths, are not uncommon on the tongue. They are frequently associated with a patch of leukoplakia, and their chief importance lies in the fact that they are liable to become epitheliomatous. In all cases the growth should be removed by carrying an elliptic incision around its base. The wound on the tongue is closed with a few catgut stitches.

Among the rarest forms of tumour of the tongue may be mentioned fibromyoma, rhabdomyoma, osteoma, and chondroma.

CYSTS

Dermoid cysts are occasionally met with underneath the tongue. They lie on the upper surface of the mylohyoid, between the genio-hyo-glossi muscles. Histologically they present the same characters as in other situations. They may be noticed soon after birth, or may only attract attention in adult life. The tumour usually forms a swelling under the chin, varying in size from a pigeon's to a turkey's egg. When it bulges towards the mouth it may simulate a retention cyst of the salivary glands, from which, however, it differs in that it is more deeply placed, pits on pressure, and presents a yellowish instead of a purplish appearance.

The *treatment* consists in excising the tumour, preferably from the outside.

Hydatid and Csyticercus cysts are very rarely met with in the tongue.

THYRO-GLOSSAL CYSTS AND TUMOURS

It is convenient here to refer to certain cysts and solid tumours which may develop in connection with the embryonic tract, which passes from the isthmus of the thyroid gland to the foramen cæcum at the base of the tongue—the thyro-glossal tract. The solid tumours have the same structure as the thyroid gland, and they may grow to a considerable size. In some cases the thyroid tissue appears to be physiologically active, as the removal of the growth has been followed by symptoms of myxœdema. The cysts are characterised by being lined with ciliated epithelium, and having thyroid tissue in their walls. These tumours may be met with at any age; in some cases they are congenital. They are usually situated at the base of the tongue, but have been met with in the region of the hyoid bone. As seen from the mouth they are of a bluish brown or dark red colour. As the walls of the cysts are very vascular they are liable to bleed frequently. The blood may fill the cyst, causing it to enlarge suddenly, or may escape into the mouth. The frequent variations in size of the swelling and the repeated attacks of bleeding help to distinguish thyro-glossal cysts from other swellings at the base of the tongue. The growth may attain sufficient dimensions to interfere with speech or swallowing, in which case it should be removed. When not causing inconvenience it is best left alone.

MALFORMATIONS OF THE TONGUE

Complete or partial *absence* of the tongue, due to arrested development of the tuberculum impar, is extremely rare.

Occasionally the fore part of the tongue is *bifid.* The split may merely amount to a notch at the tip of the tongue, or it may extend for a considerable distance into the substance of the organ. This deformity may be associated with other congenital malformations of the face and jaws. The function of the organ is not seriously interfered with, and the operation of paring and uniting the edges of the cleft is only called for to remove the disfigurement.

Congenital tongue-tie or *ankyloglossia* is a condition in which the tip of the tongue is bound down to the floor of the mouth by an abnormally short and narrow frenum, or by folds of mucous membrane on each side of the frenum. This deformity is extremely rare. It is very common, however, for parents to blame a supposed "tongue-tie" when a child is slow to begin to speak, or when he speaks indistinctly or stammers, and surgeons are frequently requested to divide the frenum under such circumstances. In the vast majority of cases an examination shows that there is nothing wrong with the frenum, and that the child is not tongue-tied. This fact is emphasised because hæmorrhage, septic complications, deforming cicatricial contractions, and other untoward effects have followed the needless division of the frenum.

cases of endocarditis, acute phlegmon of the pharynx, septic thrombophlebitis, and acute suppurative osteomyelitis, may arise from a primary infection of the tonsils by pathogenic organisms.

Even in conditions of health the tonsillar crypts are often filled with evil-smelling contents consisting of disintegrating epithelium cells, fibrinous débris, and various septic organisms, amongst which staphylococci, streptococci, pneumococci, and leptothrix are abundant.

Under the combined influences of certain external causes and a lowered condition of the general health, such organisms may rapidly develop, causing a local inflammation accompanied by constitutional effects.

The part played by the "supratonsillar fossa" in many forms of recurrent tonsillar inflammation has been investigated by Paterson (3). This vestigial space of varying size and shape represents a portion of the second branchial cleft, and is situated between the anterior and the posterior faucial pillars, at the upper end of the tonsil. It communicates with the mouth by an orifice between the aforementioned pillars and also with the uppermost lacunæ of the tonsils. Like the latter it is often filled with septic matter which may find difficulty in discharging into the mouth, and lacunar or peritonsillar inflammation may result, or the retained material may calcify and ultimately form a tonsillar calculus. A strabismus hook will be found an excellent instrument for examining this cavity.

Tonsillitis or inflammation of the tonsils may be acute or chronic. Acute tonsillitis may be classified in the following manner:[1]—

I. Toxic tonsillitis, without any visible exudate.
    (*a*) Rheumatic.
    (*b*) Catarrhal or influenzal.
    (*c*) Tonsillitis occurring in infective diseases, *e.g.* scarlet fever, measles, syphilis, etc.
II. Infectious tonsillitis, with exudate.
    (*a*) Lacunar tonsillitis.
    (*b*) Diphtheritic.
III. Parenchymatous tonsillitis (quinsy), } both of which may end in suppuration.
IV. Peritonsillitis, }
V. Phlegmonous or gangrenous tonsillitis (in septic pharyngitis).
VI. Acute ulcerative tonsillitis.

Acute Tonsillitis

Etiology.—Lacunar, parenchymatous, and peritonsillar inflammations, which are the more frequent forms of tonsillitis, have so many features in common that they may be discussed together. Such inflammations most frequently occur during adolescence, and not rarely appear in epidemic form during the spring and fall of the year.

Whilst cold acts as an exciting cause of tonsillitis, the rheumatic diathesis has, during recent years, been almost universally regarded as the most important predisposing cause of the throat affection. The frequent association of the diseases in the same individual, their common etiological factors, and their amenability to the same remedies lend support to this view. On the other hand the sudden onset, clinical course, infectious nature of and constitutional symptoms associated with acute tonsillitis, seem to point to a general toxæmia of which the tonsil is the source.

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[1] The above classification is modified from that of Sandner (*Medical Summary*, Dec. 1900).

Other predisposing causes of acute tonsillitis are the presence of chronically enlarged tonsils, the gouty diathesis, and conditions of ill-health.

Acute lacunar tonsillitis is undoubtedly contagious, the infective material being conveyed by milk, water, and air. Defective sanitary conditions will often explain the frequent occurrence of tonsillitis in a household. In young children acute inflammation of the fauces should awake suspicions of the onset of one of the exanthems, while secondary syphilis must not be forgotten in the adult.

Traumatism, septic matter arising from carious teeth, and intranasal operations not aseptically performed, are local causes of acute tonsillitis.

Recurrent attacks are often due to the accumulation of septic matter in the supratonsillar fossa (*vide supra*), the outlet of which has been unduly narrowed by previous attacks of inflammation.

Morbid Anatomy and Pathology.—In the toxic forms of tonsillitis, *e.g.* rheumatism, influenza, and scarlatina, there is a general hyperæmia of the fauces in which the tonsils participate. In scarlatina the parts may be œdematous and of a livid red colour.

In lacunar tonsillitis, although the inflammation is mainly limited to the lacunæ, the tonsils are often much swollen and hyperæmic, while the crypts are filled with a yellowish creamy exudate composed of epithelial scales, leucocytes, fibrinous débris, and various septic organisms, amongst which staphylococci and streptococci usually predominate, while diplococci, tetracocci, and pneumococci are present in less numbers. Hence, while a mixed infection is the rule, yet occasionally an acute tonsillitis may be due to a pure monococcal infection.

When streptococci predominate the constitutional symptoms are liable to be more severe. If the Klebs-Loeffler bacillus be present the case should be considered diphtheritic, even though clinically identical with lacunar tonsillitis.

Parenchymatous tonsillitis is characterised by inflammation of the lymphoid and deeper tissues of the gland; the latter is often much swollen, and eventually suppuration ("quinsy") may result.

Peritonsillitis signifies an inflammation which is supposed to commence in the connective tissue bed in which the tonsil lies. Probably the infection arises from one of the neighbouring lacunæ, or even more often from the supratonsillar fossa, in which region the peritonsillar abscess most frequently points.

In acute ulcerative tonsillitis a well-defined ulcer (or ulcers) with slightly raised edges of varying size, and covered by a greyish slough, occupies more or less of the surface of an uninflamed tonsil. Staphylococci, streptococci, and a rod-shaped bacillus staining with methyl-blue, have been found in connection with the ulcers.

Symptoms.—The onset of lacunar tonsillitis is usually ushered in by feelings of general malaise, sore throat, and fever. Sometimes the latter takes the form of a rigor. With the rapid increase of the inflammation, the quickened pulse, pyrexia varying from 101° to 103°, foul tongue, constipated bowels, febrile urine, and general prostration, all indicate the severity of the toxæmia, which may be further manifested by a fine erythematous rash which occasionally appears on the body. To the same cause must be attributed certain forms of endocarditis which may appear during an attack of tonsillitis not necessarily of rheumatic origin. Such general symptoms are more marked in lacunar than in peri- or parenchymatous tonsillitis, in which affections the pain in swallowing and other local symptoms are more pronounced. In these forms the dysphagia may be so severe that the patient, rather than swallow even his saliva, will allow it to dribble from the mouth.

When the tonsils are much swollen the voice is thick and guttural, and the breathing may be noisy, especially at night.

Deafness, earache, and tinnitus indicate an extension of the inflammation to the pharyngeal orifices of the Eustachian tubes and nasopharyngeal mucosa.

Examination of the throat in lacunar tonsillitis will reveal the crypts filled with a yellowish exudation which may often be wiped away without difficulty. Both tonsils and the surrounding faucial tissues may be much inflamed although the inflammation may at first be limited to one gland.

In peritonsillitis and parenchymatous inflammation, the tonsil with the neighbouring tissues and submaxillary glands may be so inflamed that any movements of the head, especially opening the mouth, are very painful, and the general discomfort of the patient is greatly increased.

At first one tonsil is usually inflamed and much swollen, but not uncommonly the subsidence of the inflammation is followed by acute symptoms in the other gland.

In these forms of tonsillitis suppuration often occurs some four to five days from the onset of the disease, the abscess in peritonsillitis tending to point in the region of the supratonsillar fossa. In such a case the soft palate is much swollen above and in front of the tonsil, and should the pus not be evacuated by the surgeon, it will eventually burst into the mouth, and thus afford rapid relief to all the symptoms.

In septic or "hospital sore throat" grey membranous patches may be found on the tonsils (or fauces), and in the former case are due to suppuration of the lymphoid follicles. Lacunar inflammation may be associated with these appearances. The general symptoms of malaise, pyrexia, etc., indicate the toxic nature of the disease.

Acute ulcerative tonsillitis is met with in weakly, anæmic individuals, and gives rise to few constitutional symptoms. The neighbouring lymphatic glands are not enlarged.

Prognosis.—This is almost invariably good. During the early days of tonsillitis in children the possibility of a developing exanthem must be borne in mind. Apart from the intensely septic and gangrenous forms which may be followed by visceral complications, tonsillitis is rarely a fatal disease.

Diagnosis.—Lacunar tonsillitis is the only form of inflammation which may give rise to difficulties of diagnosis, for in some cases it may be impossible from clinical appearances and symptoms to say whether the disease be diphtheria or lacunar tonsillitis. This will be especially the case when both maladies are prevalent in the same locality. For example, in a certain case of diphtheria the membrane may be limited to the tonsils and even to the orifices of the lacunæ, there may be no albumin in the urine, the general asthenia may not be marked, but in the course of a few weeks paralytic sequelæ develop, and meanwhile the possibility of disseminating the disease has been unrestrained. On the other hand, in a case of lacunar tonsillitis the exudate from one crypt may fuse with that of its neighbour, it may not be easy to remove it, albumin may be present in the urine especially if the temperature be high, and the submaxillary glands may be enlarged, while the patient may be in a low, asthenic condition. Therefore in all doubtful cases the patient should be isolated while a bacteriological investigation is being made. If the Klebs-Loeffler bacillus be found the case must be regarded as diphtheria, and treated as such. If it be a case of lacunar tonsillitis the isolation will have minimised the risk of other members of the household becoming infected.

Acute ulcerative tonsillitis would be distinguished from a chancre of the tonsil by the combined absence of stony hardness of the tonsil and enlarged cervical glands; from tertiary ulceration by the history and effect of anti-syphilitic treatment.

Treatment.—In all forms of tonsillitis it is well to commence treatment with an efficient aperient. There are few more suitable for this purpose than calomel followed by a saline draught. In lacunar tonsillitis with high temperature, salicylate of soda in twelve-grain doses every four to six hours, until its physiological effects are produced, will usually give good results in relieving pain and lowering temperature. It may be combined with a diaphoretic, *e.g.* acetate of ammonia. Fifteen grains of benzoate of soda every two hours is said to give excellent results after some six doses have been taken.

Drachm doses of the ammoniated tincture of guaiacum, given in hot milk every two hours until purging is produced, is especially useful in lacunar and parenchymatous tonsillitis. It may also be prescribed in five-grain doses of the powder.

Drop doses of aconite tincture given every hour is a favourite remedy for acute pharyngeal inflammations in children.

With regard to local remedies, considerable relief may be afforded in lacunar tonsillitis by spraying the inflamed tonsils with a hot alkaline solution flavoured with listerine; in other cases by painting the tonsil with equal parts of guaiacol and olive oil. Others recommend the sucking of ice-pills, or the frequent application by means of a brush of menthol dissolved in liquid paraffin (gr. xv. ad ʒj.). Swallowing of food is rendered easier by a preliminary painting of the tonsil with cocaine (gr. xv. ad ℥j.), while during the act of deglutition pain is greatly minimised by firm pressure externally just in front of the tragus of the ear. Gargles are generally useless because of the pain they cause, but sedative pastilles, *e.g.* borax and chlorate of potash, menthol, cocaine and borax, are sometimes useful. Sips of sweetened lemon-juice will enable the patient to cleanse the throat of the sticky exudation so abundant in many cases of tonsillitis. Hot external applications occasionally give relief, but a cold Leiter's coil applied early in the disease will do much to alleviate subsequent suffering by reducing the inflammation.

In parenchymatous or peritonsillar inflammation the tonsil should not be punctured unless it be fairly certain that pus is present, but when that is the case the operation should not be delayed for a moment.

The puncture should be made towards the upper and outer side of the tonsil over the region of the supratonsillar fossa. A partially sheathed bistoury should be passed in for at least half an inch, and then withdrawn downwards and inwards so as to enlarge the aperture of entry. If pus does not follow the withdrawal of the knife a pair of Lister's sinus forceps should be passed into the puncture and opened in one of two directions, for in this way the abscess may often be discovered and relieved.

After an acute attack of tonsillitis the patient should be put on a tonic plan of treatment, and should seek change in the country or seaside. When he has quite recovered his health the tonsils should be removed if they are enlarged.

An acutely inflamed tonsil should never be removed unless it is giving rise to serious difficulty of respiration.

II. Chronic Inflammation of the Tonsils—Enlarged Tonsils

Etiology.—While in many instances the morbid enlargement of the tonsils during the early years of life seems to occur without any definite reason, so that one is driven to ascribe such hypertrophy to some congenital influence, yet it is no less a well-established observation that in other cases the enlargement is due either to repeated attacks of inflammation in the tonsil, or dates from an attack of one of the acute specific diseases. In yet other instances it may be one of the numerous manifestations of the strumous diathesis. Enlarged tonsils usually make their appearance before the age of puberty and tend to shrink after that period of life has been passed.

Morbid Anatomy and Pathology.—Three varieties of chronically inflamed tonsils are most frequently met with.

1. Chronic lacunar tonsillitis, in which the tonsils are generally somewhat enlarged and in which the lacunæ are filled with yellow, evil-smelling, cheesy accumulations consisting of epithelium scales, the débris of inflammatory exudation, and a variety of septic organisms. Such accumulations may often be squeezed out of the lacunæ or from the supratonsillar fossa. In certain cases such caseous plugs may calcify and produce tonsillar calculi, or "tonsilloliths." In rarer instances the lacunar inflammation may lead to the production of epithelial outgrowths, or "papillomata" of the tonsil. Should the mouth of a lacuna become blocked a chronic tonsillar abscess, or the formation of a cyst, may result.

The surface of a tonsil subject to chronic lacunar inflammation is often scarred and presents a trabeculated appearance; in long-standing cases of the disease the lymphoid tissue of the follicles may have almost entirely disappeared, having given place to epithelial proliferation of the lacunæ and general fibrotic overgrowth.

2. Fibrotic, in which the enlarged tonsil is mainly composed of fibrous overgrowth.

3. Lymphoid.—This is particularly common in children. In it there is excessive development of the lymphoid tissue, and such growths are frequently accompanied by adenoid vegetations of the nasopharynx.

Hypertrophied tonsils vary in size and shape. They may be so moderately enlarged that unless acutely inflamed they give rise to little trouble; on the other hand they may reach such a size as to almost meet in the middle line and cause great difficulty in breathing.

Sometimes they are more or less pedunculated, or while projecting very little from the fauces they may be enlarged from before backwards in an irregular lymphoid mass, which below passes imperceptibly into the lingual tonsil.

Symptoms.—In children respiratory difficulties and some alteration of the voice are common symptoms. The patient breathes noisily at night, and during the day is liable to choking attacks when taking food. The obstruction to free nasal respiration engenders mouth breathing, followed by a lack of development of the facial bones which is indicated by the long, narrow face and laterally contracted nostrils, together with the high arched palate, projecting incisor teeth, and retracted upper lip. The obstructed respiration also tends to the production of the pigeon-breast deformity, especially in rickety subjects. The voice is usually thick and guttural.

Temporary attacks of deafness or other ear symptoms are not uncommon, and in a small number of cases certain reflex phenomena, such as cough, vomiting, epigastric pains, etc., have immediately disappeared on removal of enlarged tonsils.

Enlarged cervical glands are frequently present, and no doubt are due to absorption of septic matter from the lacunæ and tonsillar surfaces (*vide supra* "General Considerations"). Probably the listlessness, mental apathy, and unhealthy aspect of many patients with enlarged tonsils, are in part due to absorption of septic matter into the system from the tonsils, as well as to imperfect oxygenation of the blood arising from deficient respiratory movements.

It must not be forgotten that many of the above symptoms are often aggravated or partly caused by the co-existence of adenoids or hypertrophic conditions of the nasal and nasopharyngeal mucosa.

Diagnosis.—There can rarely be any difficulty in this, but it may be as well to point out that sudden unilateral enlargement of a tonsil in an adult should arouse suspicions of malignant disease.

Treatment.—If the tonsils be so enlarged that they produce any of the aforementioned symptoms, it is the duty of the surgeon to advise their removal, and to discountenance all ineffectual and temporising methods, such as the application of astringent paints, caustics, change of air, etc. This is the more imperative when we remember—

(*a*) That the operation of tonsillotomy is, with certain reservations, practically free from risk.

(*b*) That a great improvement in the general health almost always results.

(*c*) That evil results are almost sure to follow if enlarged tonsils be allowed to remain untreated.

Hypertrophied tonsils may be removed by the following methods:—

1. By means of the guillotine, *e.g.* Mackenzie's or Reiner's (see "Morcellement" and "Enucleation," p. 304).
2. By "morcellement," when the shape of the tonsils or other reasons render the first method impossible or inadvisable.
3. Enucleation for reasons similar to those last mentioned.
4. Galvanic cautery or "ignipuncture."
5. Wire ecraseur.

The removal of tonsils by means of a bistoury is only mentioned in order to condemn it as slow, painful, often incomplete, and more likely to be followed by hæmorrhage than any other method.

1. *Guillotine.*—Except in young, nervous children, tonsillotomy should be performed without a general anæsthetic. In other cases the painting of the tonsillar surfaces with a 10 per cent solution of cocaine is all that is necessary. When the guillotine is used it will greatly assist the surgeon if an assistant, standing behind the patient, pushes the tonsil inwards by external pressure applied behind the angle of the jaw. As a general rule, the slight hæmorrhage which follows the operation ceases spontaneously in the course of a few moments.

The patient should be kept quiet for twenty-four to forty-eight hours, and food should be cold and of a soft consistence.

In the case of young children in whom a general anæsthetic is advisable, the writer prefers that the head should hang backwards over the end of the table immediately the operation commences, and that if adenoids be present, their removal should immediately follow that of the tonsils.

Hæmorrhage after Tonsillotomy.—Apart from cases of hæmophilia, profuse hæmorrhage following tonsillotomy is uncommon, but the surgeon must always be prepared to meet it. It is more likely to occur in the fibrotic tonsils met with after twenty years of age than in young children, and its source is usually some branch of the ascending pharyngeal artery. In rare cases a rapid and fatal hæmorrhage has resulted from the wounding of an abnormally placed internal carotid artery. The hæmorrhage may immediately follow the tonsillotomy, or come on a few hours after the operation, especially under the influence of exertion or excitement.

Treatment of Hæmorrhage after Tonsillotomy.—If the hæmorrhage be only a free capillary oozing the patient should be induced to sit up and sip some iced water or suck pellets of ice. Gargling with hazeline and water (3 to 1) is often a useful remedy, as also is the application of styptic colloid to the bleeding surface.

A pad of cotton wool dipped in a creamy solution of tannic acid ʒiij., gallic acid ʒij., and water ℥j., and applied to the tonsil will rarely fail to check hæmorrhage, especially if counter pressure be at the same time applied externally and maintained for three to five minutes.

If the arterial jet can be seen, an endeavour should be made to seize the bleeding point by means of suitable forceps, and either twist or apply a ligature to it.

The hæmorrhage nearly always ceases if the patient becomes faint, and it would only be when every other method had failed that one would have to consider the advisability of tying the external carotid artery.

In all cases the patient should remain quiet for forty-eight hours after the operation, and only take cold, soft food.

2. "*Morcellement.*"—This method is suitable for long flat tonsils which cannot be made to project through the ring of a guillotine. By means of "punch-forceps," as introduced by the writer, such tonsils may be safely, quickly, and effectually removed at one sitting. The method is also convenient for removing tonsils in adults, or in any case where hæmorrhage may be feared.

3. "*Enucleation*" has been advised for large tonsils which on account of their shape are not suitable for removal by the guillotine. The anterior pillar is dissected off the upper part of the tonsil, and the index finger inserted above the gland, which is peeled downwards out of its bed. The method gives excellent results, but is not often necessary if "morcellement" be adopted. For enucleation a general anæsthesia will be necessary, a practical point in which it compares unfavourably with "morcellement."

4. *Galvano-puncture.*—This method has been advocated for the gradual destruction of tonsils in adults where tonsillotomy might be followed by hæmorrhage. At each sitting three or four punctures are made into the substance of the tonsil, and repeated in the course of a few days until the tonsil has shrunk sufficiently. The method is long, somewhat painful and tedious, and with "morcellement" to fall back upon the writer considers the use of the cautery rarely necessary.

5. *Wire Ecraseur.*—The wire loop has been used both hot and cold for removal of tonsils in adults, because of the freedom from hæmorrhage. The pain after removal is often exceedingly severe, especially when some minutes have been occupied in tightening up the snare. Otherwise the matter is safe and efficient.

Chronic Tonsillar Abscess

The etiology of the condition has already been referred to. The abscess may be situated in the tonsillar substance or in the supratonsillar fossa.

In the latter case it often finds an exit into the mouth, and the patient complains of a frequently recurring unpleasant taste. In some cases it is possible to cause the pus to flow by pressing the tonsil from below upwards. Such abscesses produce aching pains in the side of the throat and various forms of throat discomfort. Sometimes the abscess contents caseate or calcify, and a tonsillolith or calculus results, which if hidden in the supratonsillar fossa may easily escape notice.

Such abscesses should be opened by guillotine, bistoury, or punch-forceps, and their cavities made to freely communicate with the mouth, when they will at once granulate up and evince no tendency to recur.

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Torticollis. *See* WRY NECK.

Toxicology.

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TOXICOLOGY, the science which treats of poisons, comprises a description of the nature and constitution of poisons, the symptoms and post-mortem appearances produced by them, the treatment of poisoning, and the physiological and chemical tests by means of which poisons may be recognised. To the medical practitioner the most important of these are the symptoms, treatment, and post-mortem appearances; consequently, in this epitome they will receive the chief consideration.

It is difficult to accurately define the word poison, inasmuch as almost any substance, that is not absolutely inert, may produce injurious effects if taken in excessive amount, when it would come under the definition of a poison; yet such substances are included in the preparation of ordinary food, as for example nutmeg. A practical definition of a poison may be thus formulated: a poison is a substance which, either by being absorbed into the living organism, or by its chemical action on the tissues, injures health and destroys life. Among the conditions which have to be taken into account when estimating the injurious effects which may be produced by poisons are: age, idiosyncrasy, habit, and state of health, together with the physical condition and the mode of administration of the poison. The susceptibility of infants and children to opium and the exceptional intolerance of adults towards certain drugs—such as arsenic, quinine, or mercury—are well known. The habitual use of opium produces an unwonted tolerance towards it, as does also the presence of diseases such as delirium tremens and tetanus. The physical condition and the modes of administration of poisons tend to modify their action. Arsenic in the gaseous form, as arsenietted hydrogen, is much more virulent than ordinary white arsenic. Strychnine injected subcutaneously acts more rapidly than when taken by the mouth. When a poison is swallowed its action tends to be materially modified by the presence or absence of food in the stomach: if the stomach is empty, a corrosive poison expends its full power on the coats of the viscus; whilst if it contains a mass of solid food some of the corrosive action of the poison is expended on the food. Absorption takes place more slowly in the full than in the empty stomach and intestines; hence the action of a fatal dose of strychnine may, for this reason, be delayed or accelerated.

THE DIAGNOSIS OF POISONING.—An important indication is afforded by the sudden occurrence of acute symptoms in a person previously in his usual health. It is to be remembered, however, that a pathological condition may declare itself abruptly and give rise to the suspicion of poisoning: rupture of a previously unsuspected gastric ulcer, or immediate intestinal obstruction, are diseases of this type. Again, it is to be noted that the early symptoms produced by many poisons may simulate those of disease: arsenic produces symptoms which have been mistaken for those of cholera or of gastro-intestinal catarrh. Another circumstance indicative of poisoning is the occurrence of unusual symptoms directly after eating and drinking. Here, again, care must be exercised not to mistake the effects due to changes in the food itself, whereby toxic products have been formed, for those of an added poison. Even wholesome food, which is difficult of digestion when eaten hastily by a person who has fasted longer than usual, may give rise to vomiting and pain which closely resemble the symptoms produced by an irritant poison. If, after partaking of a common meal, a number of people are simultaneously attacked with peculiar symptoms, there is ground for suspecting the presence of poison in the food, which may be due either to noxious substances which have been incorporated with it, or to the food itself being tainted.

When a medical man is in attendance on a case and suspects poisoning, he should note in writing all that he observes, and should take possession of any suspicious substances in order that they may be chemically examined. In addition, specimens of urine, fæces, and vomit should be submitted to analysis. In cases of doubt the patient may be safeguarded by securing the presence of trained nurses, day and night, with instructions to prepare all food, to administer it and the medicine with their own hands, and not to leave the patient when on duty.

SYMPTOMS OF CORROSIVE AND IRRITANT POISONING.—A *corrosive poison* is one that destroys tissue by direct chemical action; when administered in a dilute form a corrosive may act as an irritant. In the act of swallowing a corrosive poison an *immediate* and violent pain is produced, which extends from the mouth down the œsophagus to the stomach, from whence it radiates over the abdomen. Uncontrollable retching and vomiting occur within a few minutes, the vomited matter consisting, at first, of the contents of the stomach, and subsequently of shreds of mucous membrane, coagulated mucus, and blood, the colour of the blood being often altered by the chemical action of the poison. There is intense thirst, with difficulty or impossibility of swallowing, each attempt to swallow causing increased vomiting. The patient is in a condition of extreme collapse; the surface is pale, cold, and clammy; the features are pinched, and the eyes present a terrified look. The voice is hoarse, almost inaudible; the mouth is filled with shreds of membrane and ropy mucus; the lips are swollen, and, along with the chin, probably show signs of the local action of the poison. The mouth and tongue exhibit indications of corrosion, the colour of the surface varying with the nature of the corrosion. The abdomen is usually distended. The breathing is laboured and noisy; attempts to clear the air-passages give rise to a distressing, hoarse, futile cough. The pulse is thread-like, of low tension, and often very rapid. The bowels are confined. The urine is diminished in amount, partly owing to the rejection of fluid by the persistent vomiting, and partly to the extremely low arterial tension. The mind usually remains clear to the end; death—which in some instances is preceded by convulsions—takes place in a condition of extreme collapse within twenty-four to thirty-six hours.

An *irritant poison* is one which by its specific action sets up inflammation in the digestive tract. A pure irritant does not produce corrosion, though some substances classed as irritants may act as corrosives. When a substance that acts solely as an irritant is swallowed, the symptoms do not come on in the act of swallowing, nor immediately after, as is the case with corrosives; an interval of from half an hour to an hour or more elapses. Taking a metallic irritant as a type, there may or may not be an astringent metallic taste perceived when the poison is swallowed. After a short interval, a hot, burning sensation with a feeling of constriction is felt in the throat; the burning sensation is felt in the stomach, and it rapidly develops into severe pain, which spreads over the abdomen. Violent and persistent vomiting and purging occur, the discharged matter often becoming blood-stained. There is intense thirst, and attempts to allay it provoke further vomiting. The purging is accompanied by excessive tenesmus; the motions may be blood-stained, or they may be like rice-water. Collapse sets in: the surface is cold and clammy, the pulse feeble and irregular, there is great restlessness and anxiety, the mind often remaining clear to the end. Cramps in the legs not unfrequently occur, and there may be convulsions. In fatal cases death from exhaustion usually takes place in from one to four days.

THE GENERAL TREATMENT OF POISONING.—The indications are: to remove or neutralise any poison that may be in the digestive tract, to counteract the effects of that which has been absorbed, and to promote its elimination; to keep the patient alive until the effects of the poison have passed off, and to alleviate pain and other general symptoms.

Emetics.—Half-drachm doses of zinc sulphate dissolved in a few ounces of warm water, repeated if necessary, act quickly without causing depression; or a dessert-spoonful of mustard may be given in a tumblerful of warm water. A teaspoonful of ipecacuanha wine is a good emetic for children. In addition to the emetic, the patient should be made to drink copiously of warm water in order to aid the vomiting and to wash out the stomach. In some cases it is preferable to give a hypodermic injection of one-tenth of a grain (ten minims of the B.P. injection) of apomorphine hydrochlorate. In the absence of an emetic the fauces may be tickled with a feather, or even with the finger, and copious draughts of warm water given.

The *stomach-pump* or tube is the most efficacious means of emptying the stomach. When using the stomach-pump a hard, rigid tube is to be avoided lest it should injure the œsophageal walls. The tube should be passed down the œsophagus, keeping it well against the posterior wall; some water is always to be injected into the stomach before any fluid is extracted; the object being to wash out the stomach without entirely emptying it, which might cause injury to its coats. Five or six feet of small indiarubber tubing, one end of which has been slipped over a funnel, is a good substitute for the pumps, and indeed is sometimes preferable. The free end is passed down the œsophagus, and then a pint or more of warm water is poured into the funnel which is now held vertically over the patient's mouth as high as the tubing permits. When the funnel is nearly empty, the tube close to it is pinched tight with the finger and thumb, and the funnel inverted, is depressed until it is lower than the stomach; on removing the finger and thumb the tube acts as a syphon and empties the stomach. As with the stomach-pump, the alternate introduction and withdrawal of warm water is to be persevered in until the washings are free from odour and consist of clear water. If the stomach contains much lumpy, solid matter, an emetic may be necessary before using the pump, or tube, in order to avoid clogging. Neither the stomach-pump, nor the tube, nor emetics are to be used in cases of corrosive poisoning; the proper treatment in such cases is to neutralise the poison. Carbolic acid constitutes an exception to this rule. The stomach-pump or tube is especially useful in cases of poisoning by opium, chloral hydrate, alcohol, the vegetable and most of the mineral irritants, phosphorus and the alkaloids. In strychnine poisoning it will be necessary to administer chloroform before the tube can be passed. After evacuating the stomach a purgative should be given unless spontaneous purging has occurred.

Antidotes are remedies which counteract the effects of poisons; their action is either mechanical, chemical, or physiological. Flour mixed with water acts mechanically when given in poisoning by cantharides, magnesia acts chemically in the case of the mineral acids, and atropine is regarded as a physiological antidote to morphine.

Elimination of the poison which has been absorbed may be promoted by purges, diuretics, and special remedies in the case of central poisons. The means to be taken to keep the patient alive until the effects of the poison have passed off are determined by the nature of the poison; artificial respiration in hydrocyanic acid and severe opium poisoning, external warmth in poisoning by chloral hydrate and carbolic acid, and the administration of stimulants in many forms of poisoning, are illustrations. In addition, excessive pain, useless vomiting and purging, with other general symptoms, are to be controlled by appropriate means.

Post-Mortem Appearances produced by Poisons

The most characteristic appearances are produced by corrosives, irritants, and blood poisons. Many of the more important alkaloidal poisons do not produce characteristic appearances. The indications afforded by corrosives and irritants comprise hyperæmia, softening and ulceration of the mucous membrane, with perforation of the wall of some portion of the digestive canal. Hyperæmia is a common effect of an irritant poison; it is usually most marked in the stomach, and may be either diffuse or in patches; it is most commonly seen at the cardiac end, less frequently at the pyloric end. The surface of the injected mucous membrane is often covered with viscid mucus, which may be blood-stained. Softening of the mucous membrane of the stomach is chiefly caused by corrosives, and is due to immediate chemical action. It is not a common condition, but is almost invariable in poisoning by the alkalies. Ulceration of the mucous membrane of the stomach occasionally results from irritant poisoning, due to intense local action, or to the occurrence of infarcts. Ulceration must be distinguished from the removal of patches of mucous membrane by the action of corrosives; the former is a pathological process set up by the poison, the latter is purely chemical. Perforation caused by poisoning is usually due to the action of a corrosive, and the mode of its production leaves characteristic appearances. There is no indication of limitation by inflammatory processes, the margins of the opening, instead of being thickened, are partially disintegrated, and the aperture itself is often large and of irregular outline; if caused by sulphuric acid, the contiguous parts are charred and blackened. As a result of irritant poisoning, perforation is of exceptional occurrence, and the appearances would more nearly resemble those due to an ordinary gastric ulcer which had given way.

Some of the above-described appearances are very similar to those due to disease; others are only met with as the result of poisoning. Acute inflammation of the mucous membrane of the stomach is exceedingly rare, except as the result of irritant poisoning. The colour of the inner surface of the stomach is not to be relied on as an indication of inflammation; unnatural redness may be caused by food or medicine which possesses pigmentary properties, and during the process of digestion the gastric mucous membrane is reddened. Post-mortem staining produces redness, which, however, is limited to the posterior part of the stomach, and, moreover, the appearance is different from that due to vital processes; there is no glairy mucus on the surface of the membrane, which itself is not thickened. The early stage of putrefaction leads to softening of the whole thickness of the stomach wall; whereas softening due to inflammation is usually limited to the mucous membrane, which may be detached in patches. Ulcer of the stomach is much more frequently due to pathological processes than to poisoning. When an ulcer is caused by an irritant poison, it more nearly resembles an erosion, with inflamed margin, and without the thickening and matting together of the tissues which are characteristic of the more slowly formed idiopathic ulcer. Post-mortem perforation of the stomach may take place owing to the solvent action of the gastric juice; but the margins of the irregular aperture are not coloured as by the action of a corrosive, and the surrounding mucous membrane is usually swollen and gelatinous.

Inorganic Poisons.—Corrosives

The Mineral Acids.—Of the mineral acids, sulphuric acid is by far the most energetic corrosive; it chars and destroys the tissue with which it comes in contact, and enters into chemical combination with albumin. Nitric acid ranks second as a tissue destroyer. Hydrochloric acid acts much less energetically.

The *symptoms* of poisoning by the mineral acids are those previously described (page 307) as due to corrosives. The fumes given off by nitric and hydrochloric acids, especially the latter, are prone to attack the larynx and air-passages, and thus give rise to additional symptoms.

The *treatment* consists in neutralising the acid as speedily as possible. Calcined magnesia is the best antidote; but, since saving of time is all important, any alkaline substance at hand should be made use of. In ordinary households the substance that is most likely to be available is whiting, which is impure calcium carbonate; failing this, whitewash may be scraped off the wall or ceiling. Any of these substances should be powdered, and administered suspended in water. White of egg, or soap and water, or even water itself as a diluent, should be given if nothing better can be obtained. The stomach-pump must not be used. As soon as the poison is neutralised, pain should be assuaged by hypodermic injections of morphine.

Sulphuric Acid.—*Fatal Dose.*—Half a teaspoonful caused the death of a child one year old. One fluid drachm is the smallest amount that has been fatal to an adult. Death has occurred within an hour; it usually takes place within thirty hours. Recovery has ensued after one ounce of the strong acid was swallowed.

Nitric Acid.—The smallest recorded fatal dose is two drachms. Recovery has occurred after half an ounce. Death has occurred in less than two hours; from twelve to twenty-four hours is the average fatal period.

The *fumes* from nitric acid, which has been accidentally spilt, have on several occasions caused death. Usually the dangerous symptoms, which resemble those of capillary bronchitis, do not come on until a few hours after the vapour has been inhaled.

Hydrochloric Acid.—The smallest fatal dose is one teaspoonful. Recovery has followed two ounces. Death has occurred in two hours, the usual period being from eighteen to thirty hours.

Post-mortem Appearances.—Externally there may be stains on the lips and chin produced by direct contact of the poison. The clothing should be examined for indications of the action of the acid and for the presence of early vomit, and any stained parts should be cut out and examined chemically. The mucous membrane of the mouth will probably be disorganised and detached in parts. The most profound changes will be found in the stomach and to a lesser extent in the duodenum. When strong *sulphuric acid* is the poison the inner surface of the stomach is usually darkened in colour, not unfrequently being quite black where the acid has acted most powerfully. Where not entirely disorganised, indications of intense inflammation are seen. Of all poisons sulphuric acid most frequently causes perforation of the stomach, and when this is the case the contiguous viscera may be corroded on their peritoneal surfaces by the acid which has escaped through the perforation; the colon has thus been perforated from without inwards.

When *nitric acid* is the poison the corrosive effects are rather less pronounced, and the tissues tend to show a yellowish or brownish coloration. Perforation of the stomach is less frequent than with sulphuric acid.

When *hydrochloric acid* is the poison the gastric mucous membrane is ashy grey in colour and is probably eroded; it may display indications of acute gastritis with blackened patches. Perforation is exceptional.

Tests.—Sulphuric acid gives a white precipitate with a solution of barium chloride, which is insoluble in hydrochloric acid. If some of the precipitate is mixed with an equal bulk of sodium bicarbonate, and fused in the reducing flame of the blowpipe, it is converted into a sulphide. A fragment of this placed on a clean silver coin and moistened with water produces a brown or black stain of silver sulphide.

Nitric Acid.—Free nitric acid develops a bright red when brought into contact with a crystal of brucine. If the acid is combined a drop of strong sulphuric acid will liberate it, and then the brucine reaction may be obtained.

Hydrochloric Acid.—A solution of silver nitrate gives a white curdy precipitate which is soluble in ammonia, but not in nitric acid.

Oxalic Acid not only acts as a corrosive, but it also exercises a special influence on the nervous system and on the heart.

Symptoms.—When swallowed in concentrated solution the local effects resemble those produced by the mineral acids; if the solution is less concentrated the local symptoms are less severe, and the specific action of the poison may be more obvious. The nerve symptoms are very irregular; they consist of paræsthesia, or anæsthesia of the trunk or limbs, aching and shooting pains in the loins, numbness of the tips of the fingers, tenderness of the muscles of the calves, and convulsions. Sometimes oxalic acid has a narcotic action.

Treatment.—Chalk, or whiting, suspended in a small quantity of water or milk neutralises the acid with the formation of inert salts. The alkalies and their carbonates should not be given, as the resulting salts are soluble and poisonous. All antidotes should be given in as small amount of water as will serve to suspend them, in order to limit diffusion and absorption of the poison. After the poison has been neutralised the bowels should be emptied by enemata or aperients.

Fatal Dose.—One drachm caused the death of a boy aged sixteen. Recovery has followed one ounce and a quarter. Death has occurred in ten minutes; it usually takes place within two hours, but it may be delayed for several days.

Post-mortem Appearances.—If a strong solution of oxalic acid has been swallowed the usual indications produced by corrosives are met with; the stomach may be either reddened, or it may be black, as is the case with sulphuric acid. The coats of the stomach may be softened, and, exceptionally, perforation occurs. A white zone of crystals of calcium oxalate may sometimes be seen between the cortical and the medullary portions of the kidneys.

Tests.—A solution of calcium chloride added to a solution of oxalic acid produces a white precipitate of calcium oxalate, which is insoluble in acetic acid, but is soluble in hydrochloric acid. The reaction is aided by neutralising the solution of oxalic acid before adding the calcium chloride. A solution of silver nitrate gives a white precipitate which is soluble in nitric acid and in ammonia.

Potassium Binoxalate, or salt of sorrel, or salt of lemons, is nearly if not quite as poisonous as oxalic acid, and produces similar symptoms.

Acetic and Tartaric Acids act as corrosives, or as irritants, according to the strength of solution in which they are swallowed.

Treatment.—Neutralisation with magnesia and the alkalies, with subsequent administration of morphine.

Carbolic Acid.—Although designated as an acid, phenol, or carbolic acid, has no acid reaction, but it coagulates albumin and destroys tissue, and therefore is regarded as a corrosive poison. Like oxalic acid its action is both local and remote; locally it is a corrosive, and remotely it exercises a complex influence on the nervous system.

Symptoms.—The chief difference in the action of carbolic acid as compared with other corrosives is that vomiting is not only commonly absent, but that it is actually difficult to procure; this is due to the anæsthetic action of the poison on the gastric mucous membrane. The urine is usually dark in colour, or becomes so on exposure to the air, due to the presence of an oxidation product of phenol—hydroquinone. The body temperature is low from the first, and death is threatened from cardiac and respiratory failure.

Treatment.—As already stated, carbolic acid constitutes an exception to the rule that the stomach-tube should not be used in corrosive poisoning. A soft tube should be used, and the greatest care should be exercised in passing it in order to avoid perforating the œsophagus. The stomach should be well washed out with lukewarm water, preferably with some magnesium sulphate or saccharated lime dissolved, so as to produce an innocuous combination with the phenol. White of egg and milk may be given. The application of warmth externally by means of hot bottles and flannels is of the greatest importance. Stimulants should be administered, and if failure of the respiration seems imminent, artificial respiration should be performed.

Fatal Dose.—One drachm has proved fatal, and recovery has occurred after one ounce. Recovery after much larger amounts has been recorded, after six ounces for example, but in such cases a crude form of carbolic acid was taken, containing only about 14 per cent. of phenol. Sometimes death occurs very rapidly; in one case, in three minutes; the usual period is from three to four hours. Exceptionally a case may not end fatally for forty-eight or more hours. The external application of carbolic acid, and its injection into abscess cavities, have respectively caused death.

Post-mortem Appearances.—The odour of the poison will be perceptible in the mouth and also on opening the stomach. The mucous membrane acted on by the poison is either of a white or ash-grey colour in the mouth, and usually brown in the stomach and duodenum, where it is often corrugated and toughened, or it may be softened. Erosion is uncommon.

Tests.—Bromine water gives a yellowish white precipitate of tri-bromophenol. A few drops of ammonia water and a small quantity of bleaching-powder are added to an aqueous solution of carbolic acid, and the mixture is gently warmed; a blue colour is produced, which becomes red on acidulation. The well-known odour of carbolic acid constitutes a most delicate test.

The Alkalies: Potash, Soda, Ammonia

Symptoms.—When a strong solution of one of the alkalies is swallowed the usual symptoms of corrosive poisoning occur, with the addition that purging is not infrequent. When ammonia is the poison its vapour tends to attack the larynx and thus to lead to suffocation. Death from bronchopneumonia has been caused by the inhalation of gaseous ammonia. Recovery may ensue in ammonia poisoning, even when death appears imminent. When recovery from the immediate effects of any of the alkalies takes place stricture of the lower end of the œsophagus is a common sequence.

Treatment.—Vegetable acids in the form of dilute vinegar or lemon juice should be given, with olive oil, demulcents, and opium. The stomach-tube must not be used. When ammonia is the poison a steam-tent, and possibly tracheotomy, will be needed.

Fatal Dose.—Potash and *Soda.*—Death has followed forty grains. An average fatal dose would probably be three or four drachms. Death has occurred within a few hours; more frequently it results, after weeks or months, from secondary effects.

Ammonia.—Two drachms have proved fatal, and recovery has taken place after one ounce. Death has occurred in a few minutes, the usual period being twenty-four to forty-eight hours. Life may be prolonged for months and even years, death taking place from œsophageal stricture.

Post-mortem Appearances.—Those of corrosives. The mucous membrane of the stomach is softened; it may be bright red or dark brown; it may also be eroded. Perforation is unusual. In ammonia poisoning the laryngeal mucous membrane is infiltrated and thickened, and is sometimes covered with an exudation, forming a kind of false membrane. The irritating effects of gaseous ammonia may penetrate as far as the smaller bronchi, in which tubular casts have been found. The kidneys may be inflamed.

Tests.—For *potash* and *ammonia.* A solution of platinic chloride gives a yellowish-white crystalline precipitate. A saturated solution of tartaric acid gives a white crystalline precipitate. *Soda* may be identified by exclusion: if the suspected substance has a strong alkaline reaction, and does not respond to the above-named tests, nor to those which demonstrate the presence of an alkaline earth, it may be assumed that soda is present.

IRRITANTS

POTASSIUM NITRATE or saltpetre in large doses produces violent pain in the stomach and abdomen, with vomiting and purging. Nerve-symptoms, such as unconsciousness and convulsions, pain in the loins, cramps in the legs, muscular twitchings, abnormalities of sensation, paralysis, and aphonia, have been observed. Death is usually preceded by coma; it may occur suddenly from heart failure.

Treatment.—Wash out the stomach with the tube, and give ice and opium, and, if necessary, stimulants. Warmth and the recumbent posture must be maintained.

Fatal Dose.—The smallest recorded is two drachms. Recovery has followed one ounce. Death has occurred in from five to sixty hours.

POTASSIUM CHLORATE acts both as an irritant and as a blood poison. It causes pain in the stomach and bowels with vomiting. The patient becomes delirious and somnolent; the blood is brownish in colour and viscid, due to destruction of the red corpuscles and the transformation of some of the liberated hæmoglobin into methæmoglobin. The white corpuscles are increased in number. The skin may be jaundiced and the liver and spleen enlarged. The urine may contain albumin, hæmoglobin, or hæmatin.

Treatment.—Wash out the stomach, and administer diuretics and vapour baths, along with general symptomatic treatment.

Fatal Dose.—Six and a half drachms have caused death. The fatal period ranges from six hours to as many days.

Post-mortem Appearances.—The mucous membrane of the stomach may be softened and may exhibit ecchymoses. The blood is dark brown in colour, is inspissated, and yields the spectrum of methæmoglobin; in it are many free granules of colouring matter. The kidney tubules are filled with the débris of red blood corpuscles. The spleen and liver may be enlarged.

Barium Chloride.—This salt acts locally as an irritant and centrally as a nerve poison.

Symptoms.—Shortly after the poison is swallowed the usual symptoms of an irritant poison manifest themselves. In addition, the action of the heart becomes feeble and irregular, and pain may be felt in the cardiac region. The breathing is slow and laboured; the air-passages may become filled with mucus, causing dyspnœa and cyanosis. Singing in the ears, diplopia, pains in the limbs, coma, and in some instances paralysis, afford further evidence of the action of the poison on the nervous system.

Treatment.—The stomach-pump or an emetic, unless vomiting has already occurred. Sodium, or magnesium sulphate, should be given in half-ounce doses. Hypodermic injections of morphine and external warmth are useful.

Fatal Dose.—One teaspoonful has caused death. The fatal period has extended from one hour to seven days.

Post-mortem Appearances.—The usual diffusely inflamed appearance due to irritant poisoning, with spots of ecchymoses, are usually found in the stomach.

Tests.—By dipping a clean platinum wire into a solution containing a salt of barium, and then placing it in the flame of a Bunsen burner, a green colour is imparted to the flame. Dilute sulphuric acid, or a solution of an alkaline sulphate, produces a white precipitate when added to a solution of a barium salt—the precipitate being insoluble in nitric acid.

The salts of strontium are not poisonous.

Magnesium sulphate, or Epsom salts, taken in large doses has caused death. In one case four, in another, two ounces, and in a third case one ounce, respectively caused death. Vomiting and purging may be absent.

Arsenic.—All combinations of arsenic are poisonous. The form in which it is most frequently used as a poison is arsenious oxide, commonly called white arsenic. When fresh it is glassy-looking and has a smooth, vitreous fracture; after being kept some time it becomes opaque and porcelain-like. When powdered it looks like flour. It has little taste, and no colour nor odour—properties which singularly fit it for homicidal purposes. Arsenious oxide is but slightly soluble in water; cold water dissolves about half a grain to a grain per ounce. Boiling water dissolves much more, the greater parts, however, being deposited on cooling. When powdered arsenious oxide is added to water or liquid food, the finer particles float like a white scum on the surface, and cannot be got rid of by stirring; this appearance is very significant. White arsenic cannot legally be sold in quantities of less than ten pounds unless it is mixed with soot or indigo. When arsenious oxide is combined with potash or soda it is much more soluble. Some kinds of "fly-papers" are saturated with sodium or potassium arsenite and then dried; by soaking such papers in water a strong solution containing arsenic may be obtained, a fact that has been utilised for criminal purposes. In a higher degree of oxidation, as arsenic acid, arsenic is used in the manufacture of aniline colours, and also in combination with sodium as a fly-poison. Copper arsenite, or Scheele's green, is a pigment in common use, and occasionally gives rise to chronic arsenical poisoning by being detached in a state of minute division from wall-papers, fabrics, or woodwork which have been coloured with it. Arsenetted hydrogen is an extremely potent blood poison, which from time to time causes fatal poisoning to workmen who inhale the gas. Some organic compounds of arsenic are extremely poisonous, others are but feebly so. The combination of cacodylic acid belong to the latter group, and on this account have been used medicinally, especially sodium cacodylate, of which six to ten grains (equal to about four to six grains of arsenious oxide) have been administered daily for weeks without ill effects. On the other hand symptoms of arsenical poisoning have been caused by very much smaller doses.

Symptoms of Acute Arsenical Poisoning.—In from half an hour to an hour after a poisonous dose of arsenious oxide has been swallowed, a sensation of heat, which rapidly develops into a violent burning pain, is felt in the throat and stomach; then follow nausea and uncontrollable vomiting. Violent purging sets in, and, after the normal contents of the bowels have been evacuated, the motions tend to assume a rice-water appearance, and they may contain blood. The purging is accompanied by distressing tenesmus and by a burning sensation in the rectum. There is extreme thirst, any attempt to relieve it being immediately followed by rejection of the swallowed fluid. Indications of collapse now set in; the face assumes a very anxious appearance, the features are sunken, the surface is cold, moist, and cyanosed, the pulse is small and thready, respiration is laboured, and the voice is hoarse. The tongue, at first thickly coated with white fur, often becomes red at the tip and round the edges; sometimes it is unnaturally red all over. Owing to the vomiting and the low arterial tension the urine is very scanty. Cramps in the calves add to the patient's distress. Consciousness may be maintained to the end, or death may be preceded by coma, in which condition clonic or tonic spasms may occur.

In exceptional instances the symptoms vary from the above description. The interval between the swallowing of the poison and the commencement of the symptoms may be much shorter, only ten minutes, or it may be prolonged to twelve or eighteen hours, the condition of the stomach as to food being the principal determining factor. Occasionally there is extreme collapse from the first, the gastro-intestinal symptoms being relatively insignificant; in such cases death may occur in from six to twenty-four hours. Repeated injurious doses of arsenic are frequently given in cases of criminal poisoning, the symptoms being more or less modified in consequence. As the symptoms produced by a dose of the poison are passing off a second dose is given, which may be followed by others; the result is that certain symptoms which are more commonly met with in chronic arsenical poisoning are superadded: itching of the margins of the eyelids and reddening of the conjunctivæ, with hyperæmia of the mucous membrane of the fauces, causing the patient to have a sensation as of a hair in the throat, which he tries to dislodge by constant hawking. Numbness and tingling in the fingers and toes, tenderness of the muscles of the legs, and paralysis of the feet, due to multiple neuritis, may severally occur, and, on more than one occasion, have followed a single large dose of arsenic. Death has resulted from the introduction of arsenic into the vagina, and also from the application of arsenical paste to morbid growths.

Treatment.—The stomach should be washed out with the tube, and freshly precipitated ferric oxide administered. The oxide is prepared on the spot by adding some solution of ammonia or of potassium carbonate to the tincture of perchloride of iron; the ferric oxide which is thrown down is strained off, and then given suspended in a little water. Demulcents and morphine, with the application of external warmth, should afterwards be resorted to.

Fatal Dose.—Two grains of arsenious oxide have caused death. Recovery has taken place after a teaspoonful of powdered arsenious oxide. Death usually occurs in from twelve to forty-eight hours. Death has occurred in twenty minutes, and, not unfrequently, in from two to three hours. On the other hand, the fatal period has been prolonged to the sixth, eighth, and even the sixteenth day. In these instances there were remissions in the course of the symptoms.

Post-mortem Appearances.—Externally there is nothing of significance. Internally the stomach presents signs of intense inflammation, the mucous membrane having a velvety appearance; on the general red surface darker dots or streaks are usually seen, due to small hæmorrhages; occasionally there are more extensive submucous hæmorrhages. The mucous membrane is sometimes softened and easily detached; less frequently it is eroded, and very exceptionally the stomach wall has been perforated. In fatal poisoning, it is to be noted that by whatever channel the arsenic has obtained entry into the body—by application to a malignant ulcer, for example—the stomach will be found inflamed after death; arsenic is partly eliminated through the stomach irrespective of the mode of administration. The duodenum also is usually inflamed; and occasionally the lower part of the intestinal canal, especially the rectum, shows signs of inflammation. When life has been prolonged beyond the usual period, and sometimes when not so prolonged, the liver and kidneys show distinct appearances of fatty changes.

CHRONIC ARSENICAL POISONING.—When the ingestion of small doses of arsenic is spread over a prolonged period the symptoms produced are different from those due to acute poisoning. Arsenic is well-nigh ubiquitous, and may be unconsciously received into the system in a variety of ways: from the inhalation of particles given off by arsenical wall-papers, green baize, painted wood-work, and toys, and from its presence in minute quantities in many substances which are taken with food. All food-stuffs into the preparation of which sulphuric acid enters are liable to be contaminated with arsenic. A very extensive outbreak of chronic arsenical poisoning occurred in 1900 in Manchester and the neighbourhood due, as shown by Reynolds, to the introduction of arsenic into beer, through the unsuspected contamination of some of the ingredients manufactured with the aid of sulphuric acid used in brewing the beer. In certain trades chronic arsenical poisoning is liable to occur, as in furriers who dust the skins of the animals from which furs are obtained with various substances that act as preservatives, arsenic entering into the composition of some of these powders.

Symptoms.—The early indications consist of disorders of the digestive system, along with headache, alternate constipation and diarrhœa, with loss of appetite. Then follow irritation of the eyelids with suffusion of the eyes; laryngeal irritation; a red, moist, and painful condition of the soles of the feet and the palms of the hands; various skin eruptions—erythematous, urticarial, herpetic, bullous, or eczematous; disorders of sensation in hands and feet, with excessive tenderness of the muscles of the legs, followed by more or less paralysis (multiple neuritis) with high-stepping, or tabetic gait; keratosis of the hands and feet, especially the latter; pigmentation varying from freckle-like spots to complete bronzing of the surface. There is great tendency to heart-failure, and in fatal cases death is usually due to this cause. When recovery takes place it is very slow.

The *elimination* of arsenic takes place primarily by the kidneys and bowels, and secondarily by the skin and its appendages. In the ordinary sense of the word, arsenic is not a cumulative poison, and when a single poisonous but not fatal dose is swallowed, elimination commences forthwith, and no evidence of the poison can be obtained from the urine later than ten or twelve days. On the other hand, when successive small but not minute doses are taken over a long period, as in chronic poisoning, the elimination-rate does not appear able to keep pace with the rate of ingestion, and consequently a certain proportion of arsenic is backed up in the tissues, and shows itself in the urine for, possibly, several weeks after the last reception of the poison; I have found it fifty-nine days after the final dose. After death, arsenic, which has been absorbed, is found in the largest amount in the liver; the kidneys, spleen, brain, and other soft organs contain much less. In chronic poisoning arsenic may be found in the horny scales formed by the keratosis, in the nails, and in the hair; it is also found in the bones. When a considerable quantity of arsenic remains in the tissues at the time of death putrefaction is delayed; in acute poisoning after a minimum lethal dose putrefaction would probably follow the ordinary course.

Tests.—When arsenic is in solution Reinsch's method is a good way of demonstrating its presence; this method can be used when arsenic is in organic admixture. The first and absolutely indispensable step is to prove that the reagents about to be used are free from arsenic. Into a clean flask pour three drachms of pure hydrochloric acid and two ounces of distilled water; drop in a piece of bright copper foil about three-eighths of an inch square, and allow the acidulated water to gently boil on a gauze-covered tripod over a Bunsen flame for half an hour. Empty the fluid in such a way as to allow the copper to remain in the flask; if the copper is bright and its colour is unchanged the absence of arsenic may be assumed; if the copper is discoloured the reagents must be rejected as being contaminated. Should the copper be unchanged it is left in the flask, and some of the fluid which is suspected to contain arsenic is added, along with one-sixth its volume of hydrochloric acid from the same bottle from which the first supply was obtained, and the flask is replaced over the flame. The length of time that the fluid should be allowed to boil depends upon the amount of arsenic present: if there is a considerable amount a few minutes will suffice; but if very little be present, half an hour or even an hour will be required to obtain a deposit. On removing the flask from the tripod the liquid is poured out, the copper being left as before, and the flask is partly filled with water and gently shaken so as to wash the foil; this may be repeated once or twice. The copper, purple-tinted, or possibly steel-grey, is then shaken out of the flask on to a piece of filter paper, by means of which it is dried. It is then cut in half with a pair of scissors, and the two pieces are introduced into a clean, dry sublimation tube. The tube is rapidly passed over a Bunsen flame to warm it, and the lower end of the tube is then brought to the margin of the flame and held there for a few seconds until the copper changes colour, showing that the film of arsenic has been volatilised. When the arsenic leaves the copper it combines with oxygen and deposits on the walls of the tube, a short distance above the foil, in the form of tetrahedral crystals of arsenious oxide, which present a very characteristic appearance under the microscope. If the crystals are dissolved, with the aid of heat, in a drop of water, and when cold a drop of a solution of ammonia-nitrate of silver be added, a yellow precipitate of silver arsenite is formed. In addition to arsenic, antimony, mercury, silver, bismuth, and tin are deposited on copper when boiled with it in acid solution; of these only antimony and mercury yield sublimates. With solutions containing organic matter the copper may be stained although no arsenic is present; the sublimation test, therefore, must never be omitted. When urine is submitted to Reinsch's test it is preferable to previously evaporate it down to one-fourth its volume. Solid organic substances should be pulpified and mixed with a sufficiency of distilled water as to render them fluid.

Marsh's Test.—A flask, furnished with a stopper through which a long thistle-funnel and an exit-tube pass, is charged with some pure zinc and dilute sulphuric acid. The exit-tube is fitted with a wider tube, which is filled with fragments of calcium chloride in order to dry the gas which passes through it; a length of combustion tubing drawn out small at its free end is attached to the drying tube by means of a short piece of rubber tubing. When the hydrogen, which is evolved by the action of the sulphuric acid on the zinc, has replaced the air in the flask, a Bunsen flame is allowed to play on the combustion tube a little before the narrow part is reached. If, after the flame has heated the combustion tube for half an hour, no stain is visible in the narrow part, the acid and zinc may be regarded as being free from arsenic. The suspected fluid is now introduced into the flask through the thistle-funnel when, if the arsenic is present, a stain will begin to show itself where the tube is contracted. The length of time required for the stain to develop, and the density of the resulting deposit, depend upon the amount of arsenic that is present in the flask: if there is a considerable amount the deposit begins to appear in a minute or less; if there is only little more than a trace, fifteen or twenty minutes elapse before it shows itself, in which case the experiment must be continued for an hour at the least. The deposit in the tube, if of medium density, is brownish and of a metallic lustre; when of greater density it may be black. The tube is now detached from the flask and the stained portion is heated in the Bunsen flame; the film readily volatilises, and deposits on a cooler part of the tube in the form of crystals of arsenious oxide, which may be tested with ammonia-nitrate of silver as previously described. A less delicate method of demonstrating the presence of arsenic in the gas coming from the flask is to ignite it as it issues from the end of the combustion tube, and to allow the flame to play on a cold porcelain surface such as a crucible lid; the dissociated arsenic deposits on the porcelain as a brownish, glistening film which is freely soluble in a solution of bleaching powder, and but only slightly so in ammonium sulphide. Arsenic that is in combination with organic matter requires to be separated from it before it is added to a Marsh-apparatus, as almost all organic fluids lead to the formation of froth on the surface of the contents of the flask which mounts up to the exit-tube and spoils the results.

ANTIMONY.—The preparation of antimony that is most commonly encountered as a poison is the potassio-tartrate, or tartar-emetic. This salt is very soluble in water.

Symptoms.—Immediately after a poisonous dose of tartar-emetic is swallowed, an astringent, metallic taste is experienced, followed in a few minutes by a hot, burning pain from the mouth down to the stomach, along with a sensation of constriction in the throat. Violent vomiting then occurs, and shortly after diarrhœa. Exceptionally, blood may be present in the vomit. Cases have occurred in which vomiting was delayed for an hour after the poison was swallowed. The depressant effects of tartar-emetic soon show themselves: the pulse is small, frequent, and of low tension, the surface is cold and clammy, and may be cyanosed; the breathing is slow and laboured, and the patient is profoundly collapsed, and is probably unconscious. The urine is almost entirely suppressed. Clonic spasms may precede death.

Treatment.—The poison usually causes vomiting; if not, the tube may be used to wash out the stomach; or, probably, it will suffice to tickle the throat with a feather in order to induce emesis. Tannin, or some substance containing it, such as stewed tea, should then be given so as to form an insoluble compound with any of the poison that remains in the stomach. Unnecessary vomiting should be checked by ice and morphine. External warmth and stimulants will be needed.

Fatal Dose.—Five to ten grains would probably be a fatal dose. Death has been caused by a grain and a half following a like dose taken twenty-four hours previously. Recovery has followed two hundred grains. Death may occur in from a few hours to several days. After a large dose, either a speedily fatal issue from exhaustion may be expected, or an almost equally speedy recovery.

ANTIMONY CHLORIDE, or butter of antimony, acts as a corrosive.

Post-mortem Appearances.—After a fatal dose of tartar-emetic the mucous membrane of the stomach may be inflamed and ecchymosed; it is covered with slimy mucus and is sometimes eroded. The duodenum may participate in these appearances. In some instances the gastric mucous membrane is not inflamed, but presents a pale-yellowish appearance. The liver and kidneys may show fatty changes.

The appearances produced by antimony chloride are those of a corrosive.

Tests.—Reinsch's method, as described under "Arsenic," yields an amorphous deposit in the sublimation tube, which is readily distinguishable from the crystalline sublimate of arsenic. If the antimonial sublimate is dissolved in a drop of a solution of tartaric acid, and then treated with a drop or two of sulphuretted hydrogen water, an orange-coloured precipitate of antimonious sulphide is produced. Marsh's method (see "Arsenic") may also be used. The deposit in the tube occurs nearer to the Bunsen flame, often on both sides of it. The deposit is dead black (not brown as with arsenic), or, if there be much antimony present, it may have a metallic lustre like mercury. On applying heat the deposit is volatilised with difficulty, and if the tube be filled with air, it comes down on a cooler part of the tube as a white, non-crystalline, amorphous cloud, which may be dissolved in a solution of tartaric acid and tested with sulphuretted hydrogen water, as with the sublimate obtained by Reinsch's test.

MERCURY.—The chief poisonous salt of mercury is the mercuric chloride; occasionally the red and the white precipitates give rise to poisoning.

Symptoms of Acute Mercurial Poisoning.—Immediately after a poisonous dose of the perchloride has been swallowed, an acrid metallic taste, accompanied by a sensation of constriction in the throat, is experienced. A burning sensation quickly develops, which spreads from the mouth, down the œsophagus, to the stomach, and then radiates over the abdomen. Vomiting of white slimy masses, frequently tinged with blood, quickly follows. Diarrhœa, with severe tenesmus and colicky pain in the abdomen, then occurs, the motions being watery, often blood-stained and mixed with shreds of mucous membrane. The mucous membrane of the mouth and pharynx is white and swollen; the voice is hoarse, and the breathing difficult and noisy. The patient is profoundly collapsed; the surface is cold, clammy, and cyanosed; the pulse is small and irregular; the urine is suppressed, any that may come away contains albumin. There may be convulsions. If the patient survives, salivation will probably set in twenty-four or more hours after the poison was swallowed.

Strong solutions of corrosive sublimate applied to ulcered surfaces have caused death. Intra-uterine injections of a solution of 1 in 2000 of corrosive sublimate have also caused death. Absorption of a solution of corrosive sublimate may take place through the unbroken skin, and accidents occasionally occur from the extensive use of this salt as an antiseptic.

The symptoms produced by red and white precipitates are those of an irritant; the toxic action of these salts is much milder than that of corrosive sublimate.

Treatment.—In corrosive sublimate poisoning, if vomiting has not occurred, white of egg should be administered, followed by an emetic; the former to combine with the poison and render it inert, and the latter to dislodge the compound, as it is soluble in excess of albumin. Demulcents, opium, and stimulants will then be required.

Fatal Dose.—Three to five grains of corrosive sublimate may be regarded as a fatal dose for an adult; recovery has followed three hundred and seventy grains. When death occurs it is usually within three or four days; it has occurred in a few hours, and has been delayed for seven or eight days. Red precipitate has been recovered from after a dose of a teaspoonful and more. Thirty-five grains of white precipitate have caused death. Recovery has followed two drachms.

Post-mortem Appearances.—After a fatal dose of corrosive sublimate the mucous membrane of the mouth and œsophagus is swollen, softened, and ash-grey or white in colour. The mucous membrane of the stomach is also swollen and softened, and may be deeply injected and ecchymosed; eschars may be present; sometimes there is little or no appearance of inflammation. The small intestines are less affected than the colon and rectum, which are often deeply injected and may be ulcerated. Interstitial nephritis is usually found to have occurred, and there may be a deposit of calcareous salts in the cortex of the kidney.

Chronic mercurial poisoning is almost exclusively due to the use of mercury, or its salts, in certain trades, such as looking-glass silverers, thermometer and barometer makers, and workers in quicksilver mines, and manufactories in which preparations of mercury are made; furriers and bronzers also use mercurial salts, and are liable to suffer from chronic poisoning. The symptoms comprise loss of appetite, of flesh, and of strength, with colicky pains, stomatitis, salivation, and tenderness of the gums, with extreme fœtor of the breath. Anæmia, occasional vomiting, and diarrhœa may occur, and eczematous or other eruptions of the skin. Later a fine tremor develops in the muscles of the tongue and face, which tends to spread to the arms and legs. As a rule more or less paralysis occurs, and there may be disturbance of the mind.

Tests.—With mercuric salts potassium iodide gives a scarlet precipitate soluble in excess. Stannous chloride gives a white precipitate which changes to grey. With soluble mercurous salts potassium iodide gives a green precipitate.

Lead.—The acetate, the carbonate, and the chromate are the salts chiefly met with in acute poisoning by lead.

Symptoms.—The salts of lead act as mild irritants. If an ounce of the acetate be swallowed a metallic taste is at once perceived, followed by the usual burning sensation, which is common to metallic irritants, in the gullet and down to the stomach. In about half an hour, vomiting of white, opaque masses, which may be tinged with blood, occurs. There is thirst and colicky pains in the abdomen, which come on in paroxysms, and which are accompanied by rigidity of the abdominal muscles; the patient attempts to obtain ease by bending forward and compressing the abdomen. Usually the bowels are constipated, occasionally they are relaxed, the motions being black from the presence of lead sulphide. The urine is partially suppressed. There is great prostration, vertigo, pains in head and limbs, numbness, and paræsthesiæ, cramps in the calves, and occasionally paralysis. The tongue is coated, and the breath is offensive. The pulse is small and frequent. The blue line on the margins of the gums, which is characteristic of chronic lead poisoning, is rarely present. Most cases of acute lead poisoning recover.

Treatment.—The stomach should be washed out unless there has been free vomiting. Sodium and magnesium sulphates should be given in half-ounce doses, dissolved in half-pints of water; the resulting lead sulphate should then be got rid of by purgation. Demulcents and opium will be required.

Fatal Dose.—The fatal dose of lead acetate is unknown; recovery has followed one ounce. The *post-mortem appearances* are those of a mild irritant.

Chronic Lead Poisoning or Plumbism.—The extensive use of lead in trade pursuits, and the many ways in which beverages and articles of food may, accidentally, become contaminated with it, together with the characteristic cumulative properties it possesses, all tend to make chronic lead poisoning a much too common occurrence. Of trade pursuits in which lead is used there is no end; beginning with the extraction and reduction of the ore, an endless sequence is encountered of manufactures in which lead in one form or other is used. Workers in the manufacture of lead salts especially of white and red lead, painters, plumbers, gas-fitters, file-cutters, printers, dippers, and other workers in potteries, glass-cutters, coach-makers, workers in enamelled sheet-iron ware, in the construction of electrical accumulators, in the preparation of white vulcanised rubber, solderers, type-founders, and lead pipe-makers, comprise only a selection of the artificers who handle lead. Apart from trade risks there are countless channels by which lead may find its way into the system; snuff, tobacco, and certain kinds of sweets are frequently enveloped in so-called tin-foil, into the composition of which lead largely enters; beer is often drawn from the cask through leaden pipes; tinned fruits may be contaminated with lead which the acid of the fruit dissolves out of the solder, hair dyes are frequently composed of solutions of lead salts; the glaze of many earthenware vessels, and that of so-called enamelled iron-ware, readily yields lead to any acid substances, such as rhubarb, that are stewed in them. The most prolific source of dietetic lead poisoning is drinking-water. Notwithstanding the well-nigh universal knowledge of the risk which attends the introduction of lead into the system, the use of lead cisterns and pipes for the storage and conveyance of drinking-water is still common. New lead pipes are more dangerous than old ones, which gradually become protected with an insoluble coating of basic lead carbonate. The presence of carbonic acid, of chlorides, nitrates, and nitrites in the water increases its solvent action on lead. Peaty water, and water containing other organic matter, is especially prone to dissolve lead; the action of bacteria on organic matter tends to the formation of nitrates and nitrites. The amount of lead in drinking-water need only be very small in order to cause chronic poisoning; $\frac{1}{100}$ of a grain per gallon is sufficient.

Symptoms.—Dyspeptic troubles, with loss of appetite, offensive breath, and unwonted constipation, are the earliest symptoms. Then follows anæmia, the skin acquiring a sallow, unhealthy appearance. Probably at this period a blue line will be found at the margin of the gums, due to the deposition of particles of lead sulphide in the papillæ of the mucous membrane. Small quantities of sulphur-containing food cling to the teeth, and undergoing slow decomposition give off sulphuretted hydrogen, which combines with the lead that is in a state of solution in the gums. Where the teeth are absent there is no blue line. The blue line may exist without any other symptom of plumbism which, on the other hand, may be present, although no blue line is visible. At this period the patient will probably be thinner than usual owing to the disturbance of nutrition. The next symptom which usually occurs is colic as a rule, radiating from the umbilicus over the abdomen, the muscles of which are retracted and tense. It is often intermittent, with constant heavy pain between the attacks. It is relieved by pressure, except when it is extremely violent, and then the abdomen is tender and intolerant of pressure; in such cases, especially in young women, the patient rolls about the bed with contortions that might be mistaken for an hysterical seizure. During the attacks the pulse is slow and of high tension, there is little or no elevation of temperature; the bowels are usually obstinately confined, but occasionally they are rather relaxed. Deep-seated pain of a boring kind, most frequently about the knees, but sometimes affecting the elbows and shoulders, often occurs, to which the name arthralgia is given. After colic, one of the commonest symptoms of chronic lead poisoning is paralysis of the extensor muscles of the hands and fingers, producing "wrist drop"; the supinator longus usually escapes, and, as the affected muscles undergo atrophy, this muscle stands out in marked contrast to those that are wasted. When a patient suffering from wrist drop holds out his arms horizontally before him, with the palms downwards, the hands drop and cannot be raised, hence the name "wrist drop." Exceptionally the paralysis begins in the muscles of the upper arm, the deltoid, biceps, and coraco-brachialis being affected, and in this—the upper-arm type—the supinator longus is attacked. In each type both arms suffer, though one may be more affected than the other. The legs are not usually attacked, and never until the arms have been affected for some time; the extensors of the foot are the first to suffer; the tibialis anticus, like the supinator longus, usually escapes. In exceptionally bad cases the paralysis may spread to the muscles of respiration and deglutition. The characteristics of lead paralysis are: little if any disturbance of the sensory fibres, with the exception of occasional localised patches of anæsthesia, together with extreme atrophy of the affected muscles, the paralysis in ordinary cases being limited to the extensor muscles of the fore-arm.

In the course of chronic plumbism psychical disturbances may manifest themselves; sleeplessness, drowsiness, excitability, with hallucinations and wild delirium, may occur. Epileptiform convulsions are not uncommon, especially in women; sometimes they come on unexpectedly in the early stage of plumbism, before the commoner symptoms develop; more frequently they occur later in the course of the disease. They may be repeated at intervals for days, the patient remaining unconscious for a considerable time after each attack. Convulsions in lead poisoning are of serious import; they frequently portend a fatal result. In rare cases anomalous nerve symptoms may supervene—as general paralysis, ataxia, with girdle-sensation and loss of muscular co-ordination, probably due to neuritis, with possibly some changes in the cord; and, as observed by Oliver, a condition which closely resembled bulbar paralysis. Optic neuritis may occur as a consequence of plumbism; it may produce no noticeable impairment of vision, or it may lead to absolute blindness which may be permanent. Not unfrequently some improvement of vision takes place even in the worst cases.

When lead is taken into the system for prolonged periods it tends to cause chronic nephritis, probably in the first instance of the parenchymatous variety, but leading eventually to interstitial nephritis with the formation of the granular kidney. As a result albumin will be present in the urine, but probably not until the system has been under the influence of lead for some time. The relation borne by granular kidney to lead on the one hand and to gout on the other has long been observed. There is no doubt that individuals with a gouty tendency succumb readily to the influence of lead, and that in such subjects gout is developed by the lead, but whether chronic lead poisoning can determine gout apart from the presence of a gouty diathesis is doubtful. Pregnant women usually abort when under the influence of lead—a fact so well known in some districts as to cause certain preparations of lead, *e.g.* diachylon-plaster, to be regarded as ecbolics.

Treatment.—The patient should be removed from the influence of lead and any special symptoms combated, colic and arthralgia by opium, paralysis by local massage and electricity, with rest. Potassium iodide is usually given, but with doubtful efficacy. Elimination is best promoted by fresh air, hot baths, general massage, moderate purgation, and a judicious amount of exercise.

Tests.—Sulphuretted hydrogen produces a brown or a black precipitate with lead salts. Potassium iodide gives a yellow precipitate which dissolves on boiling and crystallises, on cooling, in gold-coloured scales. Potassium chromate gives a yellow precipitate, and sulphuric acid a white precipitate.

COPPER.—Metallic copper is but slightly, if at all poisonous; copper coins, accidentally swallowed, have remained in the digestive tract for six and nine months without causing any symptoms of poisoning. The salts of copper by which acute poisoning is produced are the sulphate and the acetate.

Symptoms.—Immediately on swallowing a poisonous dose of one of the above salts a metallic astringent taste is experienced, followed, after a short interval, by pain in the stomach and abdomen, by vomiting and purging, and by collapse. The early vomit is green or blue, and probably the inside of the mouth and lips are tinted blue. The distinction between vomit coloured by a copper salt and by bile is determined by the addition of a little ammonia water: the coppery vomit is turned a deep blue, whilst the bilious vomit is unaltered in colour. Pain in the head often occurs, and occasionally convulsions. Jaundice has been observed.

Treatment.—Vomiting usually occurs spontaneously, and may be promoted by draughts of warm water; if no vomiting occurs the stomach-tube should be used. White of egg, barley water, thin arrowroot and milk should afterwards be given.

Fatal Dose.—Not known. One ounce each of the sulphate and of the acetate have severally proved fatal. Death may occur in a few hours, but is more usually delayed for several days.

Post-mortem Appearances.—Those of an irritant poison, with possibly bluish or greenish coloration of gastro-intestinal mucous membrane, which may be distinguished from bile-staining by the addition of ammonia water. The liver may show fatty changes.

Chronic Copper Poisoning. — Although the introduction of repeated minute doses of copper salts into the system does not produce symptoms of poisoning comparable with those produced by like doses of lead, it must not be assumed that repeated small doses of copper are innocuous. It is stated that workers in copper, even those engaged in the manufacture of verdigris, never suffer from chronic copper poisoning. Some observers, however, report cases which occurred in copper workers, that support the view held by Filehne and others—founded on experiments on animals—as to the resemblance between the toxic effects of copper and those of the other heavy metals. Chronic copper poisoning is mostly discussed in relation to the presence of salts of the metal in food; the contamination may be accidental, or it may be intentional. Accidentally, copper finds its way into food through the use of unclean brass cooking utensils; the copper boilers and hot-water cylinders in general use are also sources of contamination. Copper salts are purposely added to certain foods and condiments to improve their appearance; green-peas and some kinds of pickles are frequently thus treated. The law does not specifically prohibit the addition of copper to aliments, it merely forbids the addition of any material which renders food injurious to health, and leaves it to the court before which the case is tried to decide what is, and what is not, injurious to health. This allows great latitude of opinion among expert witnesses, especially as it is difficult to obtain direct evidence of the toxic action of small doses of copper.

Tests.—Potassium ferrocyanide gives a chocolate-coloured precipitate, and ammonia water an azure blue colour with a solution of a copper salt. A piece of bright iron wire, or a steel needle, placed in a solution of a copper salt which has a slightly acid reaction, becomes coated by a film of metallic copper, the reaction being aided by heat. The wire, subsequently placed in a few drops of ammonia water, imparts a blue tint to the liquid.

SILVER.—Acute poisoning by a salt of silver is very rare, most of the recorded cases being due to the accidental swallowing of a piece of lunar caustic whilst it was being used to cauterise the throat. The *symptoms* are those of a corrosive and an irritant. The *treatment* consists in the administration of common salt, followed by an emetic. White of egg and ice, with hypodermic injections of morphine, are subsequently to be given. The fatal dose is unknown.

Post-mortem, there will be patches of greyish-white where the poison came in contact with the mucous membrane, in addition to the usual appearances produced by an irritant.

Chronic poisoning by silver is usually the result of prolonged medicinal treatment with silver salts. One of the chief symptoms is argyria; a lead-blue discoloration of the skin, due to the deposition of reduced silver in the papillary layer of the corium, which is permanent.

Tests.—Hydrochloric acid produces a curdy precipitate with a solution of a silver salt, which is soluble in ammonia water but is insoluble in nitric acid.

ZINC.—The salts by which acute poisoning is caused are the sulphate and the chloride. The *sulphate*, in poisonous doses, produces violent vomiting and the usual symptoms of an irritant. The treatment is limited to attention to the symptoms, as the poison is usually evacuated spontaneously and its toxic action is but feeble. The fatal dose is not known. Recovery has followed one ounce. The *chloride* is a powerful corrosive. Its action is to be combated by teaspoonful doses of sodium carbonate, white of egg, and opium.

Tests.—The formation of a white sulphide on the addition of sulphuretted hydrogen to a neutral or alkaline solution of a zinc salt, is a characteristic reaction. The gelatinous, opalescent precipitate given by potassium hydrate, and soluble in excess, is also characteristic. Potassium ferrocyanide gives a yellowish, gelatinous precipitate.

TIN.—Poisoning by tin-salts is very rare. It has usually occurred from the presence of the metal in the juice of tinned fruits, the acids of which, acting on the solder, or on the tinned surface of the containing vessel, have charged the juice with the corresponding salts of tin. The *treatment* consists in emptying the stomach and administering white of egg, milk, ice, and opium.

Tests.—Stannic salts give a yellow, and stannous salts a brown, precipitate with sulphuretted hydrogen. With mercuric chloride and a little hydrochloric acid, stannous salts give a white precipitate which turns grey and subsequently black.

BISMUTH.—Two drachms of bismuth subnitrate have caused death with symptoms of gastric irritation, together with stomatitis and foul breath. The treatment consists in evacuating the stomach and then giving ice, and opium if necessary.

IRON.—One ounce and a half of the tincture of perchloride of iron caused death after five weeks. The symptoms and treatment are those of an irritant.

CHROMIUM.—Half an ounce of a solution of *chromic acid*, 100 grains to the ounce, has caused death after being applied to papillomatous growths; chromic acid has produced severe toxic symptoms after being swallowed. *Potassium dichromate*, in two-drachm dose, has caused death in four hours; recovery has followed 270 grains. Lead chromate has also caused death. The symptoms produced are those of acute gastritis, with disturbance of respiration. The *treatment* consists in evacuating the stomach and then giving magnesium carbonate, or chalk suspended in water. Opium will probably be required and also stimulants.

NON-METALLIC ELEMENTS

PHOSPHORUS.—The toxic action of phosphorus is chiefly utilised as a means of committing suicide, for which purpose either rat-paste, which consists of finely divided phosphorus mixed with fatty matter artificially coloured, or the heads of matches, are swallowed. Phosphorus poisoning is more common in women than in men, partly because phosphorus is taken by women in order to procure abortion. Occasionally young children are fatally poisoned by sucking the heads of matches.

Symptoms of Acute Phosphorus Poisoning.—The primary symptoms are those of an irritant. They come on in from a few minutes to twelve, or more, hours. The early vomit and the patient's breath may appear luminous and yield a garlic-like odour. There is intense thirst, eructations, and a painful sensation in the gullet and stomach, with a foul tongue and a tender tympanitic abdomen. At this stage diarrhœa is more frequently absent than present. In rapidly fatal cases (which are the exception), the gravity of the symptoms increases until the patient dies in eight or ten hours. The more usual course is that the primary symptoms diminish somewhat in intensity, the diarrhœa, if present in the early stage, ceases, and the patient appears easier for one or two days, with persistence of the thirst and possibly occasional attacks of vomiting and a tender state of the abdomen. Then the secondary symptoms develop: the white of the eye and the skin acquire a jaundiced hue, pain is felt in the epigastric region, and the liver, and sometimes the spleen, are enlarged. The abdominal distension and tympany increase, the vomiting returns and is now accompanied by diarrhœa, both vomit and motions, probably, containing blood. The urine is high-coloured and scanty and contains albumin and bile pigments. There is a general hæmorrhagic tendency, shown by epistaxis, hæmaturia, purpuric spots, and, in women, metrorrhagia. The pulse is quick, but there is not much elevation of temperature. Stupor and coma supervene, and death soon follows: occasionally the mind remains clear. The temperature usually sinks towards the end, but, exceptionally, it rises and has been known to continue to rise for a short time after death.

The most characteristic feature of acute phosphorus poisoning is altered metabolism, shown by diminished oxidation of tissues and consequent modification of the excretory products. This is specially the case as regards the nitrogenous constituents of the urine: the urea is diminished, the deficiency being compensated by an excess of ammonia. Leucin and tyrosin are occasionally present in the urine. The altered metabolism is further shown by the presence of non-nitrogenous bodies in the urine, such as sarcolactic acid and, exceptionally, sugar.

Treatment.—Empty and wash out the stomach either with warm water or with a 0·1 per cent solution of potassium permanganate. Turpentine may be given in half-drachm doses. If diarrhœa does not occur, repeated movements of the bowels should be procured, as phosphorus may remain unoxidised in the intestines and may be absorbed; castor oil or other fatty matter should not be given, as fat is a solvent for phosphorus and would promote its absorption.

Fatal Dose.—The smallest recorded fatal dose is a grain and a half; recovery has followed six grains. Death has occurred under twelve hours; it is usually delayed from the second or fourth day to a week.

Post-mortem Appearances.—If death occurs early, the cavities of the body, when opened, may yield the odour of phosphorus and occasionally phosphorescence has been observed. The mucous membrane of the stomach and duodenum is usually yellowish or greyish-white; limited ecchymoses and erosions may be present. The rest of the intestinal tract shows no changes except that small ecchymoses may be seen; exceptionally, the intestines have been found inflamed. The heart and kidneys show signs of fatty degeneration and the spleen is usually enlarged. The principal post-mortem sign of phosphorus poisoning is seen in the liver, which is large, of a yellow colour, and of doughy consistence. This appearance is due to the presence of a large amount of fat which replaces the normal liver tissue. In some respects acute phosphorus poisoning resembles acute yellow atrophy of the liver; both are of toxic origin, the latter being probably caused by the action of micro-organisms.

Chronic phosphorus poisoning is caused by inhalation of the fumes of phosphorus which causes necrosis of the upper and lower jaw-bones. The phosphorous vapour acts on any bone, the periosteum of which is exposed; hence it attacks the jaws of work-people in lucifer-match manufactories, whose teeth are defective, obtaining access to the bone by way of the decayed teeth. If the teeth are sound, the vapour cannot reach the bone.

IODINE, *iodoform*, and *potassium iodide* have each, on rare occasions, caused death,—mostly from the medicinal use of these substances.

BROMINE has, on two or three occasions, caused fatal poisoning from being swallowed in the liquid form, and also from inhalation of bromine vapours. One or two cases of poisoning by *potassium bromide* are recorded, one being fatal.

CHLORINE has caused death to work-people in chemical and bleach-works. The severe dyspnœa which the inhalation of chlorine produces is best relieved by putting the patient in a steam-tent.

BORIC ACID has caused death by the injection of a five per cent solution into the pleural sac, after evacuation of an empyæma, by washing out the stomach, and by the use of a vaginal tampon of boric acid. The symptoms are depression, erysipelatous eruption on the face, vomiting, diarrhœa, and collapse. Skin eruptions, such as erythema and urticaria, on various parts of the body, are the most constant signs of boric poisoning.

GASEOUS POISONS

SULPHURETTED HYDROGEN.—With the exception of accidents in chemical works, poisoning by sulphuretted hydrogen generally results from the inhalation of sewer-gas. When the percentage of sulphuretted hydrogen is limited, the symptoms produced are a sensation of "catching of the breath," a small pulse, oppression in the head, vomiting, dizziness, and probably diarrhœa, with great muscular prostration; with a large percentage, asphyxia and heart failure, cyanosis, delirium and convulsions may occur, and very rapid death.

Treatment.—Artificial respiration, with friction over the cardiac area and along the limbs, and the application of external warmth are helpful. If the surface is hot, drenching with cold water may be tried.

Post-mortem Appearances.—Putrefactive changes usually quickly follow death; but this is not always the case. Cadaveric rigidity has been noticed to be well marked. The blood is fluid and dark in colour, consequently the viscera are darker than usual. The muscles sometimes have a bluish tint. The lungs will probably be œdematous.

CARBON DIOXIDE.—Death from this gas may occur in coal-mines, after an explosion which gives rise to "choke damp," in deep wells and excavations, in brewers' vats, and in the neighbourhood of lime- and brick-kilns. The usual method of testing the respirableness of air suspected to be contaminated with carbon dioxide is to lower a lighted candle into it; if the candle goes out the atmosphere is poisonous; if it continues to burn, however, the air is not necessarily harmless, as a candle will burn in an atmosphere that is dangerous to life.

Symptoms.—Heaviness in the head, giddiness, noises in the ears, tightness of the chest and an inclination to sleep are experienced, and, shortly, the muscles lose power, the individual falling to the ground. Subsequently, the symptoms are those of asphyxia. In a concentrated atmosphere of carbon dioxide, as in a well, or a vat charged with the gas, immediate loss of consciousness and muscular power, followed speedily by death, occurs not unfrequently to workmen who incautiously venture into such an atmosphere. No one should undertake the function of rescuer without having the noose of a rope round his body, the free end being in charge of bystanders; the omission of this precaution has often led to the multiplication of victims.

Post-mortem Appearances.—Those of death from asphyxia:—dark-coloured fluid blood, distended right heart and veins, hyperæmia of the lungs, with frothy mucus in air passages.

CARBON MONOXIDE.—Poisoning from this gas may be due to the fumes given off by slow combustion stoves, or by coke burning in an open fire-place; the death of those who are in a building on fire, from which escape is cut off, is frequently due to carbon monoxide. Perhaps the most usual way in which poisoning by carbon monoxide occurs is from breathing air contaminated with coal-gas, or, more especially, with water-gas, which is now so commonly used either to adulterate or to replace coal-gas. An atmosphere containing one per cent of carbon monoxide would soon prove fatal to those who breathed it; much less might do so if breathed for a considerable time. Coal-gas contains from four to eight per cent of carbon monoxide, whilst water-gas contains forty per cent; when water-gas is mixed with coal-gas the percentage of carbon monoxide is reduced to about sixteen.

Symptoms of Acute Poisoning by Carbon Monoxide.—A sensation of heaviness in the head, dizziness, noises in the ears, quickening of the action of the heart and lungs, oppression on the chest, and occasionally vomiting, occur along with loss of muscular power; coma quickly supervenes, and convulsions may precede death. The pulse is small, the surface is cold and aganotic, the conjunctivæ are hyperæmic, and the pupils somewhat dilated. The lips are often covered with froth.

The toxic effects of carbon monoxide are due to its affinity for hæmoglobin, with which it combines, and for which it has an affinity two hundred times greater than that of oxygen. The compound of carbon monoxide with hæmoglobin is much more stable than that of oxygen with hæmoglobin, and so long as hæmoglobin is combined with carbon monoxide it is useless as an oxygen carrier; if, therefore, more than a certain amount of the hæmoglobin be thus rendered functionless, death results from asphyxia due to arrest of internal respiration. The combination of carbon monoxide with hæmoglobin takes place progressively with each respiration made in an atmosphere contaminated with the gas; the action is strictly cumulative, so that the duration of the exposure as well as the amount of gas present has to be taken into account when considering the effects likely to be produced by a given admixture.

Treatment.—The most important object is to keep the tissues supplied with a sufficiency of oxygen to enable life to continue until the carbon monoxide is dissociated from the hæmoglobin with which it is combined; for although, in a certain degree, carboxyhæmoglobin is a stable compound, it gradually parts with the carbon monoxide whilst circulating through lungs which are breathing pure air. Artificial respiration, therefore, along with the inhalation of oxygen, when available, should be persevered with for a long time. External warmth must be maintained and stimulants administered either by the rectum, or hypodermically (in the form of ether), should the patient be unable to swallow. Bleeding, followed by the transfusion of an equal amount of defibrinated human blood, has been resorted to, but not so successfully as, on theoretical grounds, might have been expected.

Post-mortem Appearances.—Externally, the appearance is very characteristic: in a well-marked case the surface of the body is rosy-red, and the post-mortem stains are bright pink in colour. On opening the body the colour of the tissues is equally striking; the intestines are of a light red colour and the whole of the viscera are much brighter in colour than usual. The blood itself is cherry-red in colour and, for the most part, is fluid. Froth may be found in the air-passages, and the lungs may be œdematous. The tissues and the blood from a case of poisoning by carbon monoxide resist putrefactive changes for a much longer time than is usual after death from other causes.

Blood that is charged with carbon monoxide yields a spectrum which closely resembles that of oxyhæmoglobin, the two bands being slightly nearer the violet end of the spectrum than those of oxyhæmoglobin. The critical difference lies in the fact that the spectrum of carboxyhæmoglobin undergoes no change on the addition of a reducing agent to the blood. When ammonium sulphide is added to ordinary blood, the oxyhæmoglobin is reduced and its spectrum is changed from two bands to one broad band; the same reagent produces no effect on being added to blood which is fully charged with carbon monoxide. It is to be observed, however, that death usually takes place before the hæmoglobin is fully saturated with carbon monoxide; the result being that whilst the hæmoglobin that is combined with carbon monoxide resists the action of a reducing agent, that which is uncombined is reduced in the ordinary way; therefore the spectrum yielded by the blood of those who have died from carbon-monoxide poisoning usually shows a broad band of reduced hæmoglobin, with the two narrow bands of carboxyhæmoglobin superimposed.

Chronic poisoning by carbon monoxide occurs to those who work for long hours in badly ventilated rooms heated by slow combustion stoves, or gas stoves, which give off carbon monoxide, but in too small amount to produce acute poisoning. Furnacemen, stokers, and the workmen in gasworks where water-gas is made are also liable to chronic poisoning. In private houses, the use of coke in open fireplaces, leaky slow combustion stoves, and ill-ventilated gas-cooking stoves are sources of danger. A most insidious risk to health, now unfortunately very widespread, arises from the introduction of water-gas into private houses as a means of illumination; the percentage of carbon monoxide is so high that the slightest leakage in the household gas-fittings may give rise to chronic poisoning.

Symptoms.—The early symptoms are easily mistaken for simple anæmia and malnutrition. They comprise headache, neuralgic pains, loss of appetite, asomnia, anæmia, loss of flesh and breathlessness, and palpitation of the heart on exertion. Subsequently, peripheral neuritis and psychical disturbances may occur. The treatment consists in removing the patient from the source of mischief, and in dealing with the anæmia and other symptoms by appropriate medicines and change of air.

CYANOGEN COMPOUNDS

Hydrocyanic, or *prussic acid*, is one of the most deadly poisons known. *Oil of bitter almonds* contains a varying amount of hydrocyanic acid which, in the crude oil, reaches to from 5 to 15 per cent. *Potassium cyanide* is a common and dangerous cyanogen salt.

Symptoms.—When a fatal dose of hydrocyanic acid is swallowed, the symptoms usually appear within a few seconds; they may be delayed for half a minute, and have been known to be delayed for over a minute. After a few gasps the patient falls to the ground in an unconscious condition; the surface is cold, the face pallid, the eyes are staring with insensitive pupils, the breathing is gasping, and quickly ceases with a few convulsive efforts. Tetanic spasms often occur in the early stage, followed by complete muscular relaxation. The pulse is extremely rapid; it can rarely be felt at the wrist. The lips may be covered with froth; vomiting and involuntary micturition and defæcation are not uncommon. Death usually occurs within from five to ten minutes; it has been known to be delayed for over an hour. When life is prolonged for half an hour there is good chance of recovery.

Treatment.—Immediate evacuation of the stomach with stomach-pump or an emetic is indicated, but, on account of the extremely rapid action of the poison, it can rarely be put in practice. Artificial respiration, faradisation of the phrenics and the diaphragm, subcutaneous injections of ether, brandy by the rectum and, if the surface is not cold, effusion with cold water, alternated with vigorous friction and the application of hot cloths or bottles. For all practical purposes antidotes are useless.

Fatal Dose.—Half a drachm of the B. P. acid caused death in one hour and twenty minutes. One grain of the anhydrous acid constitutes an ordinary fatal dose; the ultimate result is not influenced by dilution, though the action may be slightly delayed. Recovery has taken place after half an ounce of the medicinal acid, equal to 4·8 grains of the anhydrous acid.

Post-mortem Appearances.—The eyes, glassy looking, with dilated pupils, are usually prominent; the fingers and the jaws are clenched and the lips are covered with froth; the post-mortem stains may be light red in colour. On opening the body, the odour of the poison may be perceived; the blood is almost always fluid and is sometimes light-coloured, in which case the various mucous membranes and other tissues may also be light-coloured.

Potassium cyanide acts like hydrocyanic acid with the addition of erosion and softening of the mucous surfaces, with which the poison came in contact, due to the action of the potash. The inner surface of the stomach may be deeply injected and softened, or eroded. Five grains of the salt has caused death, and recovery has followed forty grains.

Oil of bitter almonds in a teaspoonful dose has caused death.

Tests.—Place a small drop of a solution of silver nitrate on the concave surface of a watch-glass and invert it over a substance suspected to contain free hydrocyanic acid; in a short time, if the acid be present, the transparent drop becomes milky white from the formation of minute crystals of silver cyanide, which are soluble in hot, concentrated nitric acid. This test may be applied over the mouth of a dead body recently poisoned by hydrocyanic acid, or over the stomach after it has been opened. If a drop of a solution of potassium hydrate be substituted for the silver solution and, after exposure over the acid, a drop of a solution of ferrous sulphate is added and then a drop of hydrochloric acid, a precipitate of Prussian blue is obtained. If potassium cyanide was the poison, sufficient tartaric acid to produce an acid reaction must be added to any suspected fluid, before it is tested as above, in order to set free the hydrocyanic acid.

ORGANIC POISONS

ALCOHOL.—Acute poisoning by alcohol varies from what is easily recognised as alcoholic intoxication to a profoundly comatose condition which cannot be distinguished from apoplexy and many other causes of total insensibility. The face may be either flushed or pale, the conjunctivæ are injected, the pupils may be either contracted or dilated, the breathing is slow and more or less stertorous, the pulse is scarcely perceptible, the surface is cold and clammy, and on account of the extremely low arterial tension and laboured breathing the face is usually cyanotic. If the case goes on to a fatal issue, the lungs become œdematous and cardiac failure occurs.

Treatment.—The stomach-pump or an emetic is to be resorted to, and hot coffee administered, which probably can only be accomplished with the aid of a tube. Friction applied to the surface, alternating with cold douches should the skin be hot, along with attempts to rouse the patient from time to time, are helpful. Should the patient not respond, the faradic current may be applied, and in extreme cases artificial respiration may be needed. If there is any doubt as to the cause of the coma, keep the patient under observation as a possible cerebral lesion, until the diagnosis is obvious. The diagnosis may be aided by adding a few drops of potassium dichromate to some of the patient's urine in a test-tube and then allowing some strong sulphuric acid to flow down the side of the tube to the bottom, where a green colour is developed if alcohol be present.

Post-mortem Appearances.—If the patient died shortly after drinking a large quantity of spirit, the indications will be characteristic. The stomach and various cavities of the body yield the odour of the spirit which was swallowed. The mucous membrane of the stomach may be injected or pale. The lungs are hyperæmic, and the right side of the heart and veins are filled with dark-coloured fluid blood. The bladder usually contains a large quantity of urine, which may be tested as above described. If the deceased was an habitual drunkard the usual tissue changes due to chronic alcoholism will also be present.

CHLORAL HYDRATE.—Soon after a poisonous dose has been swallowed the patient becomes drowsy and then comatose. The face is cyanotic, or is pallid, and the entire surface is very cold and moist. The respirations are slow and laboured; the pulse is small and, in the later stage, is slow. The pupils are usually contracted. Death takes place from heart failure.

Treatment.—The stomach should be emptied by the tube or an emetic, and hot coffee injected into it. The body should be wrapped in blankets and hot bottles applied. Friction of the surface is useful. If breathing fails, artificial respiration must be carried on, and hypodermic injections of a twenty-fifth of a grain of strychnine administered. Alcohol may be given by the mouth or rectum, and ether subcutaneously. Attempts should be made from time to time to rouse the patient.

Fatal Dose.—Twenty grains have caused death to an adult, and three grains to a child one year old. Recovery has followed 420 grains. Death has occurred in fifteen minutes; it may be delayed for six or more hours. There is no characteristic post-mortem appearance.

Test.—To a test-tube nearly full of a solution of chloral hydrate add a single drop of ammonium sulphide, and mix by closing the tube with the thumb and inverting it. Then heat the upper stratum of the liquid in the flame, when it at once darkens in colour and afterwards becomes turbid.

CHLOROFORM.—When a poisonous quantity of chloroform is taken into the system, either by inhalation of its vapour or by swallowing the poison in the liquid state, the face becomes pale and cyanotic, the features are sunken, the entire surface is cold and clammy, the pupils are insensitive to light and are frequently dilated; the corneal reflex is abolished, the breathing is stertorous, the pulse is small and slow and of low tension. Death occurs from paralysis of the respiratory centres or from cardiac failure. When chloroform is swallowed in the liquid state gastro-intestinal irritation is produced by direct contact of the poison with the mucous membrane.

Treatment.—When the poison has been swallowed the stomach should be emptied and washed out with the tube. The inhalation of amyl nitrite and artificial respiration will probably be needed whether the poison was swallowed or its vapour was inhaled. The patient should be placed in the horizontal posture and external warmth applied. If heart failure threatens, invert the patient so as to keep the brain supplied with blood.

Fatal Dose.—Swallowed in the liquid state seven fluid drachms caused the death of an adult, and one drachm caused the death of a boy four years old. Recovery has occurred after four ounces. Death has taken place in one hour, and has been delayed for forty-eight hours.

Post-mortem Appearances.—With the exception of signs of irritation and softening of the mucous membrane of the stomach, and possible fatty changes in the liver, kidneys, and heart, no indications of the action of the poison are present.

SULPHONAL has frequently given rise to symptoms of poisoning, and on several occasions has caused death. One of the most characteristic indications that sulphonal is acting injuriously is an abnormal coloration of the urine. After sulphonal has been taken, in medicinal doses, for some time, the urine has often been observed to vary from burgundy red to reddish black in colour; this is due to the presence of an unknown pigment associated with hæmatoporphyrin, an iron-free derivative of hæmatin, which demonstrates that the drug is acting as a blood poison. Vomiting and pain in the stomach and abdomen, profuse perspiration, accelerated pulse and respiration, reeling gait, ataxia, and suppression of the urine, have also been recorded. Death has taken place from cardiac failure. Enormous doses of more than an ounce—three ounces in one case—have been recovered from. When sulphonal, or trional, is being given for prolonged periods the urine should always be inspected at frequent intervals, and if it be discoloured the drug should at once be stopped.

Carbon Bisulphide.—Acute poisoning by this substance is very rare. In one instance half an ounce caused death in a little over two hours; recovery has followed two ounces. The cause of death is paralysis of the respiratory centres. The treatment consists in emptying the stomach, applying warmth to the body, and using artificial respiration if the breathing flags. Elimination of any of the poison that has been absorbed should be promoted by purgatives and diuretics. The tendency to drowsiness which is usually manifested should be combated as in poisoning with narcotics generally.

Chronic poisoning by carbon bisulphide is met with among those who are engaged in certain departments in rubber factories. The initial symptoms comprise nausea, vomiting, headache, anorexia, sleeplessness, colicky pains, and mental instability—the patient is either exalted or depressed. Later on symptoms of multiple neuritis occur: burning, numbness, and tingling in the hands and feet, followed by paralysis, producing wrist- and ankle-drop. The field of vision has been found restricted for all colours; amblyopia and scotomata, without retinal changes, are common.

Petroleum and Paraffin oil have produced dangerous symptoms and even death, but they cannot be regarded as active poisons. Some kinds appear to be much more noxious than others; on more than one occasion half a pint of petroleum, or of paraffin oil, has been swallowed without causing more than temporary disorder. On the other hand severe symptoms have occasionally been produced by lesser quantities, and in one or two instances death has resulted. The symptoms produced are not constant; they comprise vomiting, abdominal pain, the odour of the poison in the breath, drowsiness, collapse, feeble pulse, sighing respiration, cyanosis, and the presence of some of the oil in the motions and even in the urine. The motions have been mixed with blood. The pulse and respiration rates have been much accelerated; the pulse to 140, and the respirations to 50 in the minute.

Benzene, also called benzole, produces toxic symptoms which resemble those caused by alcohol. Fatal poisoning has resulted from the inhalation of the vapour of benzene. In addition to the odour of benzene in the breath, the respirations are slow—may be only eight to the minute—and stertorous; the pulse is usually quick, and when death takes place it has been observed to be due to cardiac failure. When recovery has taken place the odour of benzene in the breath has persisted for two or three days. One ounce has proved fatal.

Nitro-benzene has caused death in small doses, such as twenty drops; recovery has followed nearly one ounce. The symptoms comprise giddiness; loss of power; vomiting; quick, feeble pulse; shallow, irregular breathing; subnormal temperature, and a peculiar cyanotic appearance of the face and fingers, with dark blue lips. The treatment, as with benzene, is to wash out the stomach, to apply external warmth and friction, and, if necessary, to resort to artificial respiration.

Coal Tar Derivatives.—Aniline, often called aniline oil, speedily causes symptoms of poisoning when swallowed; six drachms have caused death. The symptoms resemble those caused by nitro-benzene; the most remarkable being a peculiar blueness of the body, more marked than ordinary cyanosis, which persists after the breathing has become natural, and may occur without any disturbance of the respiration.

The *treatment* is the same as for nitro-benzene.

ANTIFEBRIN has frequently produced "cyanosis" and other poisonous symptoms when administered under medical supervision. Of recent years the sale of "headache powders," which contain from four to ten grains of antifebrin, has placed the drug within the reach of ignorant people who freely resort to it, and take it in a most reckless way. In one instance, a woman took six of these powders every day for a month, which caused the skin to become bluish grey for more than a fortnight. The application of antifebrin, as an antiseptic, to raw surfaces has caused death.

ANTIPYRIN has occasionally given rise to symptoms of poisoning, but not so frequently as antifebrin. In addition to the blue discoloration of the cheeks and lips, excessive doses of antipyrin have caused urticarial and other rashes to break out over the body.

PHENACETIN on two occasions has caused death, and has often caused serious symptoms, such as dyspnœa, vomiting, diarrhœa, headache, and vertigo, together with the blue—sometimes almost black—hue of parts of the surface of the body, especially of the face; the mucous membrane of the mouth also may be discoloured. The urine may become chocolate-coloured, due to the presence of methæmoglobin. All these coal-tar derivatives, by prolonged administration, tend to act as blood-poisons.

SALICYLATE OF SODA sometimes produces untoward effects, such as hæmorrhage from the gums, epistaxis, retinal hæmorrhages, hæmaturia, albuminuria, vomiting, and urticaria. In one case great dyspnœa and stridulous breathing, with extreme slowness of the pulse, were produced by excessively large doses.

CREASOTE when swallowed in poisonous doses produces abdominal pain, nausea, vomiting, and diarrhœa. Serious symptoms have from time to time been recorded after large or prolonged medicinal doses, and, in an exceptional case, death occurred in five days to a woman of fifty-two, who swallowed three six-drop doses in milk; in this case erosions were found in the œsophagus, the stomach was injected, and the kidneys were acutely inflamed. On the other hand enormous doses have been administered in the treatment of tuberculosis without ill results; the dose has been gradually increased from one up to a hundred and more drops, and in one case up to two or three quarter drachms twice a day; in this case, however, the patient was made very ill.

ALKALOIDS AND VEGETABLE POISONS

Acute alkaloidal poisoning in general is characterised by the absence of local mischief, and by the presence of symptoms which are due to absorption of the poison and to its effect on the nerve centres. This is in marked contrast to the effect produced by acute poisoning with inorganic substances, which for the most part is attended by considerable local disorganisation or inflammatory mischief, often with relatively insignificant absorptive effects. The non-alkaloidal organic poisons stand between the inorganic and the alkaloidal poisons as regards the symptoms they produce; they cause more obvious derangement of the tissues than the alkaloids, and they exercise a greater influence, due to absorption, than do the inorganic poisons. In consequence of the absence of local effects, the alkaloids leave scanty post-mortem indications of their action; so that the sole means of confirming the diagnosis of poisoning made during life consists in the detection, by chemical analysis, of the poison in the viscera after death. Some of the alkaloids, strychnine, for example, are very stable, and, by chemical processes, can readily be separated from organic matter, and recognised even when present in very small amount; others, such as aconitine, by reason of their instability are difficult to isolate, and when isolated their identity is not capable of being definitely determined by chemical reagents, but demands additional experimentation on some of the lower animals.

STRYCHNINE is the most commonly used alkaloidal poison, both by murderers and by suicides; it also frequently causes accidental death.

Symptoms.—In three or four minutes, to a quarter of an hour and occasionally longer, muscular twitchings, accompanied by a feeling of anxiety and impending suffocation, are experienced, followed immediately by violent convulsions. The arms and legs are stretched out, the hands are clenched, and the whole of the skeletal muscles are taut and hard; then clonic spasms come on with progressively increasing violence, the head and feet are jerked backwards and the trunk forwards; very soon the spasm becomes tonic, and every muscle is stretched and contracted to the uttermost, the body often being supported on the back of head and the heels (opisthotonos). During the stage of tonic spasm respiration is arrested, or thereabouts, and the patient becomes cyanosed, the pulse being very rapid and feeble. The terror-struck face, prominent eyeballs, and dilated pupils demonstrate the physical pain and the mental anguish experienced by the patient, who is fully conscious of his sufferings and dreads immediate death. When he can speak he cries out for something to be done to relieve his agony. After a minute or more the muscles relax, the eyeballs cease to be prominent, and the pupils resume their usual size; the respiration becomes easier, the cyanosis disappears, and the pulse slows down. The patient lies exhausted, dreading a return of the spasm, which sooner or later recurs, the period of remission lasting from a few seconds to five or ten minutes. If the case is about to terminate fatally the spasms succeed each other rapidly, and death usually takes place within two hours, either from asphyxia or from exhaustion. When recovery takes place the spasms are separated by longer and longer intervals of quiescence, and are less and less violent, the patient usually recovering from the sequential state of feebleness and exhaustion in a few days.

Treatment.—Chloroform should be administered by inhalation so as to enable the stomach-tube to be introduced with which the stomach is then washed out. If the stomach-pump is not available an emetic should be given, as spontaneous vomiting rarely occurs. Chloral hydrate may afterwards be given—if necessary by being injected under the skin—in ten or twenty grain doses, dissolved in water and repeated until the spasms cease. If the patient can swallow, twenty grains may be given by the mouth and repeated as often as necessary. If death from asphyxia is threatened artificial respiration should be resorted to.

Fatal Dose.—Half a grain of strychnine sulphate caused death in twenty minutes; a little over a grain has frequently proved fatal. Recovery has taken place after ten and even twenty grains. Exceptionally, the symptoms do not commence for one or even two hours after the poison was swallowed. Death also may be delayed for three, or even seven hours; when a narcotic is taken with the strychnine still longer periods of survival have been recorded.

There are no characteristic post-mortem appearances produced by strychnine.

Tests.—Strychnine has a bitter taste which, unless disguised by strongly flavoured substances, can be detected in solutions containing 1 part in 70,000. If a fragment of strychnine is mixed with a couple of drops of strong sulphuric acid, and a few granules of manganese dioxide are stirred into the mixture with the point of a glass rod, a blue colour is produced which rapidly becomes purple and then gradually changes to red. A few drops of a solution of strychnine injected into a frog produce convulsions in a few minutes.

NUX VOMICA, which owes its toxic activity chiefly to the strychnine it contains, has occasionally caused death. BRUCINE, the other alkaloid of nux vomica, acts like strychnine, but much less powerfully. It is almost unknown as a poison, not being accessible to the public.

COCCULUS INDICUS, the active principle of which is picrotoxin, in small doses produces symptoms like those of alcoholic intoxication, and in larger doses it causes clonic spasms like those due to strychnine.

OPIUM AND MORPHINE.—The medicinal preparations—official and not official—are very numerous, and almost all of them, from time to time, give rise to symptoms of poisoning. Laudanum contains 0·75 per cent. of morphine. A drachm of paregoric is equal to a thirtieth of a grain of morphine hydrochlorate, and the strength of Dover's powder is equivalent to 1 per cent of morphine. Many of the soothing drugs which are often improperly given to children contain small amounts of opium. Dalby's carminative contains about two and a half minims of laudanum to the fluid ounce; Atkinson's preserver, three minims to the ounce. Godfrey's cordial contains from half a grain to a grain and a half of opium to the ounce. Chlorodyne contains about four grains of morphine hydrochlorate to the ounce.

Symptoms.—The first effect of a poisonous dose of opium or of morphine is excitation of the nerve-centres, which comes on in from half an hour to an hour after opium is swallowed, and in from a few minutes to a quarter of an hour if the poison be morphine. The action of the heart and of the lungs is accelerated, the face is flushed, and the mental condition is exalted; this stage is very evanescent, sometimes so much so as to pass unrecognised. The next stage begins with a feeling of lassitude, heaviness in the head, giddiness, and a progressively increasing tendency to sleep. The patient becomes drowsy and sinks into a condition of stupor. The pupils are contracted, the pulse is slow; the breathing at this period being deep and regular. The patient can be roused somewhat by being shaken and loudly spoken to, and if the dose of opium has not been very large, he may be kept more or less conscious by various methods of stimulation. When a large dose has been taken the stupor deepens into coma, and then external stimuli utterly fail to evoke any response: the muscles are relaxed, the surface is cold and clammy, the features are shrunken and either pallid or cyanotic, the pupils are extremely contracted, the pulse is still slower, and the breathing is laboured, irregular, and stertorous. If the case ends fatally the patient becomes more profoundly collapsed, the breathing more embarrassed, the pulse more irregular, and the general appearance more death-like. The pupils may dilate immediately before death, and the heart may beat for a short time after respiration has ceased. In fatal cases death usually occurs in from six to twelve hours.

If opium itself, or the tincture, was taken, the odour of opium may be perceptible in the breath. All the secretions, save that of the skin, are suppressed or diminished, so that the bowels are confined, the urine is feebly secreted, and is retained in the bladder, on account of loss of sensitiveness and of expulsatory power, and the mouth is parched from arrest of the salivary secretion. In children convulsions may occur; they are exceedingly rare in adults. Occasionally the urgent symptoms mitigate to such an extent as to remove all fear, and then, after several hours of distinct improvement, the patient relapses into coma and dies.

Treatment.—If the poison has been swallowed the stomach should be well washed out with a solution of potassium permanganate—ten to fifteen grains in six or eight ounces of water, repeated at half-hour intervals; in default of the stomach-pump an emetic may be given, or eight to ten drops of injection of apomorphine (B.P.) may be administered under the skin. Attempts should be made to rouse the patient by means of external stimuli, such as flapping the face and chest with a wet towel, or the application of the faradic current to various parts of the body. In the mild form of opium poisoning the patient may be walked about between two assistants, and, if the surface of the body be warm, occasional douching with cold water may be resorted to, the patient being kept awake, by these various means, until the effects of the poison have passed off. In cases of severe opium poisoning the treatment is different; in such cases it is worse than useless to drag a comatose person about. He should be put to bed, warmth should be applied to the surface, and, if necessary, artificial respiration should be diligently performed. Hot coffee may be injected into the stomach or the rectum, and hypodermic injections of atropine sulphate ($\frac{1}{20}$ of a grain) may be given at not too frequent intervals. Hypodermic injections of strychnine ($\frac{1}{50}$-$\frac{1}{20}$ of a grain) have proved very efficacious. Ether also may be injected under the skin.

Fatal Dose.—To adults, four grains of opium in one case, and in another two drachms of the tincture proved fatal. Recovery has taken place after three ounces, and even after eight ounces of laudanum. One grain of morphine hydrochlorate has caused death, and recovery has followed thirty, and even fifty-five grains. Recovery has followed the subcutaneous injection of about twelve grains of morphine. To infants opium is very dangerous; one drop of the tincture may give rise to serious symptoms, and even to death. Recovery, in an infant three months old, occurred after it had swallowed a teaspoonful of laudanum. In another case an infant six days old survived a grain and a half of opium.

Death has been caused by sprinkling an open sore with morphine.

Post-mortem Appearances.—There is nothing characteristic to be found after death other than the presence of some of the poison in the stomach. The blood may be dark and fluid, and there may be hyperæmia of the brain and its membranes.

Tests.—A drop of nitric acid added to a minute fragment of morphine produces an orange-yellow colour. If a centigramme of molybdic acid is dissolved, with the aid of gentle heat, in a cubic centimetre of sulphuric acid, and a drop of the mixture (when cold) be mixed with a fragment of morphine, a reddish purple colour is produced, which changes to blue. An aqueous solution of iodic acid shaken up with a little carbon bisulphide imparts to it no coloration; the addition of a trace of morphine liberates iodine from the iodic acid which, on agitation, colours the carbon bisulphide pink or rose-red.

Chronic opium poisoning, also called opium-eating and morphinism.—Opium is a poison towards which an extraordinary degree of tolerance may be acquired by persons who habitually take it in gradually increasing doses; probably due to a progressively increasing power of the tissues to destroy the morphine, rather than to an acquired indifference to its action. The habit is frequently initiated by the medicinal use of opium to relieve pain or to procure sleep. After a time the patient feels depressed and uncomfortable when not under the influence of the drug, and the temptation to take it surreptitiously is more than many people can withstand. Once begun the practice is extremely difficult to give up; hence it behoves medical practitioners to guard against exposing patients to the allurements of opium, and when the drug needs to be prescribed for a time, to earnestly warn the person taking it against prolonging its use beyond the specified term. One of the most pronounced characteristics of a person addicted to the habitual use of opium is the total absence of the moral sense, especially as regards the means used to secure indulgence in the drug. Whilst capable of special efforts, he shuns methodic work and routine duties; at the time when he feels the stimulating effects of the opium he is at his best and is companionable; at other times he is dull, restless, and captious. He will resort to any lengths to obtain the craved-for indulgence, and, after succeeding, will deny the fact with an astounding earnestness even to those who are intimately acquainted with his habits. In these cases the heart's action is irregular, the appetite is capricious, nutrition is impaired, and emaciation occurs which is often associated with an unhealthy appearance like that due to malignant disease. The patient may suffer from visceral neuroses which often give rise to attacks of violent pain in the abdomen, resembling gallstone colic; also to periodical vomiting, like gastric crises. Later on indications of perpheral neuritis may appear, such as paræsthesia, numbness of the hands and feet, with ataxic gait.

Amongst better class people the use of the hypodermic syringe has, to a great extent, replaced the more crude method of drinking laudanum. Enormous doses of morphine are thus self-administered; as much as forty grains of morphine acetate, as a daily dose, has been reached and even exceeded. Under no circumstances should a medical practitioner leave a hypodermic syringe in the possession of the patient. On some occasions the baneful habit has been brought about by the medical attendant, innocently, and without any idea of the evil that was likely to ensue, leaving a hypodermic syringe in charge of a patient who is subject to some recurrent painful affection, in order that he might be able to afford the sufferer immediate relief at a moment's notice. Sooner or later the patient takes the matter into his own hands, and uses the syringe secretly, with disastrous results.

The best treatment of chronic opium poisoning is to cut off the supply at once, which, however, is extremely difficult to accomplish unless the patient is placed under restraint. The abrupt cessation of the habit is held by some to be dangerous; there may be cases where it is so, and then gradual withdrawal combined with some special treatment may be needed. It is risky to substitute some other drug for opium, as a means of weaning the *habitué* from its use; such a procedure is likely to complicate the issue and to prolong the cure. Care must be taken, both during and after the cure, to restrain the patient from the abuse of alcohol—an occurrence not at all improbable. In addition to an intense craving for the drug so long indulged in, severe gastric pains, due to irritation of the sensory nerve-endings in the mucous membrane of the stomach by the gastric juice, are often experienced by those who have recently ceased the opium habit; the pains may be allayed by occasional doses of sodium bicarbonate. Morphine, whether swallowed or injected subcutaneously, is chiefly eliminated by the stomach; consequently, during the regular daily reception of the drug the nerves of the gastric mucous membrane are kept benumbed; when the benumbing influence is withdrawn, the nerves for a time are hyperæsthetic, and as the gastric juice at the same time tends to be abnormally acid, much suffering results.

BELLADONNA.—Poisoning by belladonna is usually due to the swallowing of a preparation of the drug which is intended for external use, or to eating the fresh berries. Atropine has caused death by being applied in the form of an ointment to a blistered surface; it has frequently produced symptoms of poisoning when a solution containing it has been dropped into the eye in order to dilate the pupil.

Symptoms.—Soon after a poisonous amount of belladona has been swallowed the symptoms begin and rapidly increase in severity. A hot, dry sensation, and a feeling of constriction, is experienced in the throat, which is accompanied by thirst; the tongue is dry, the saliva is inspissated, and swallowing is almost impossible. The pupils are dilated to the uttermost, leaving only a narrow ring of the iris visible, and they are insensitive to light. The conjunctiva are suffused. The pulse is quick—120 to 160 in the minute—and is often so small as scarcely to be felt at the wrist. In the early stage the skin is hot and dry, and is often covered with a scarlatina-like rash, which may be followed by desquamation; in the later stage the skin may be cold. Dizziness and indistinctness of vision occur, and may be succeeded by complete loss of sight and incapacity to walk. Next to the extreme dilatation of the pupils the most characteristic symptom of belladonna poisoning is the peculiar type of delirium that occurs: it is excitable, lively, and imitative; the patient is voluble, and pours forth a stream of incoherent, stammering utterances, interspersed with laughter and shouting. Imitative actions are performed with a gravity of demeanour and of persistence that is ludicrous; the patient will go through the movements of counting coins, or of putting something in his mouth and chewing it, for a prolonged time, the movements being almost machine-like in their exact sequence. Numbness of the hands and feet is frequently present, the patient usually being unable to stand. The intestines and the bladder are generally paralysed. Recovery is slow; many days elapse before the pupils regain their normal size, and visual accommodation and perception are still longer defective. After severe poisoning the memory may be enfeebled, especially for names and persons and things, producing a kind of aphasia. A large proportion of cases of belladonna poisoning recover, including those in which the symptoms were severe.

Treatment.—Wash out the stomach or give an emetic. Afterwards strong tea and coffee may be administered. Hypodermic injections of pilocarpine, one-third to half a grain of the hydrochlorate, act antagonistically. If pilocarpine is not available, quarter or half-grain doses of morphine may be substituted. During the hot stage douching and sponging with cold water is beneficial; in the more advanced stage of severe poisoning artificial respiration may be required.

Fatal Dose.—One drachm of belladonna liniment, and the same amount of the extract, have respectively caused death after being swallowed. Recovery has taken place after ten drachms of the liniment, and after half an ounce of the extract. Fourteen belladonna berries have caused the death of an adult, and recovery has followed fifty. Children are less susceptible to the action of belladonna than adults; recovery in children has followed thirty berries. Belladonna applied externally, either as a plaster, or in the form of the extract, has often produced toxic effects.

Two grains of atropine have caused death; recovery has followed five and a half grains. A child, two and a half years old, recovered from a quarter of a grain of atropine.

Post-mortem Appearances.—No characteristic indications are afforded after death from belladona poisoning unless the berries have been eaten, when fragments of them, or their seeds, may be found in the intestinal canal.

Tests.—A drop of a solution containing atropine, even only in infinitesimal amount, if instilled into the eye of a young cat, causes dilatation of the pupil. This test may be used to confirm diagnosis; a drop of the patient's urine will dilate the pupil of a kitten if dropped into its eye.

HENBANE and STRAMONIUM produce toxic symptoms resembling those produced by belladonna. Another mydriatic, DUBOISINE, acts similarly. The active principle in each case is isomeric with atropine.

The *treatment* is the same as for atropine. The fatal doses are not known. One-eighth of a grain of hyoscyamine swallowed along with one-eighth of a grain of morphine sulphate caused death. The hypodermic injection of one-thirtieth of a grain of hyoscine caused severe symptoms, followed by recovery. Seventeen or eighteen grains of extract of stramonium caused death. The instillation of one-hundredth of a grain of duboisine sulphate into the eyes produced severe toxic symptoms, followed by recovery.

No characteristic post-mortem appearances are produced by any of these atropaceous plants.

INDIAN HEMP (*Cannabis Indica*) is a hypnotic which, in the form of *haschish,* is used in the East to procure sensuous hallucinations. It has often caused toxic symptoms and, occasionally, death, but the fatal dose is not known. The treatment would be the same as for opium.

GELSEMIUM.—Poisoning by yellow jasmine is usually due to excessive medicinal doses, or to idiosyncracy on the part of patients for whom it has been prescribed. The symptoms are:—Giddiness, loss of speech, clonic spasms, uncertainty of movement of the limbs, unconsciousness, and dilatation of the pupils. The treatment consists in evacuating the stomach with tube or emetic, and in the subsequent administration of stimulants, with the application of external warmth and artificial respiration if needed. Hypodermic injections of one-twentieth of a grain of atropine, or one-thirtieth of a grain of strychnine, may be given.

COCAINE.—This alkaloid has frequently given rise to dangerous symptoms when used to procure local anæsthesia. The symptoms vary somewhat. There may be clonic spasms, or convulsions, unconsciousness, rapid pulse and respirations, dilatation of the pupils, with delirium in some cases. The treatment consists in washing out the stomach, if the poison was swallowed, in administering stimulants and also chloroform vapour, if the clonic spasms interfere with respiration, in which case artificial respiration may be required. If the cocaine was injected subcutaneously the treatment is the same except as regards washing out the stomach. Ten grains of cocaine hydrochlorate caused the death of an adult within fifty minutes after the poison was swallowed; recovery has taken place after upwards of forty grains. Death has been caused by the injection of twenty minims of a 4 per cent. solution of the hydrochlorate into the urethra. Three and a half grains of cocaine injected into the breast of a woman preparatory to an operation caused immediate epileptoid convulsions, and death in twenty minutes. In almost all fatal cases death occurred within an hour, and in most cases within ten or fifteen minutes.

Chronic cocaine poisoning is an analogue to chronic morphinism. It is initiated by the medical administration of cocaine by hypodermic injection, and by nasal and laryngeal insufflation of atomised solutions. The *habitué* frequently adheres to the original method, so that if the drug was prescribed for naso-pharyngeal treatment, he will continue to take it in the same way, many times a day, for an indefinite period. Mental apathy and moral degeneration result, and the patient is miserable unless he constantly resorts to the one thing which he has come to regard as necessary to his existence. Anomalous pains and disorders of the digestive organs, with corresponding emaciation, occur. A peculiar disturbance of sensation is often produced by the habitual use of cocaine: the patient feels as though grains of sand, or small round bodies, or in some instances worms, were under the skin. The treatment, obviously, is withdrawal of the drug. To accomplish this it may be necessary to place the patient, temporarily, under surveillance.

TOBACCO.—Nicotine, the active principle of tobacco, is one of the few liquid alkaloids; it paralyses the cardiac nerves, and causes contraction of the peripheral blood-vessels. Acute poisoning by tobacco is usually accidental. It has occurred from the injection of an infusion into the rectum to destroy worms; from the application of an infusion to the skin in order to kill parasites; and, as a practical joke, from pouring the juice out of a well-smoked pipe into beer, or spirits, about to be drunk by a partially inebriated person. In one notable instance nicotine was used homicidally, the victim dying five minutes after the poison was administered. Severe toxic effects have been produced by smoking tobacco—on one occasion, at least, ending fatally. When the poison has been swallowed the treatment consists in washing out the stomach, or in administering an emetic, and then placing the patient in the recumbent posture, giving stimulants, promoting external warmth and, if necessary, performing artificial respiration. One twenty-fifth of a grain of strychnine may be injected subcutaneously with advantage, and repeated if required. There are no characteristic post-mortem appearances: the odour of the poison may be perceptible on opening the stomach, the mucous membrane of which may be injected or ecchymosed.

Chronic tobacco poisoning is due to excessive or prolonged smoking of strong tobacco, to chewing tobacco, to taking snuff, and to the inhalation of fine particles of tobacco by workers in tobacco manufactories. The symptoms comprise dyspepsia, chronic catarrh of the mucous membrane of the pharynx and trachea, blunting of the senses of taste and smell, irregular action of the heart, faintness, tremor, and amblyopia. The symptoms that usually cause the patient to seek advice are the excessive and irregular action of the heart, and the defect of vision. Tobacco amblyopia is probably due to pyridine, or to picoline, as much as, or more than, to nicotine, which is decomposed when the tobacco is burnt. With rare exceptions tobacco amblyopia is only met with in old smokers—those who have indulged in the habit freely for fifteen or more years; so that it is uncommon before forty years of age. It is due to the presence of a central scotoma, especially for red and green; the periphery of the field of vision remains unaltered. The symptoms of chronic tobacco poisoning pass away on cessation of the habit which caused them; the amblyopia may not disappear for several months. The administration of strychnine is said to be helpful.

SPOTTED HEMLOCK, *Conium maculatum*, like tobacco, yields a liquid alkaloid—conine—which possesses a characteristic mousy odour. It paralyses the motor nerve-terminals, and subsequently the motor centres of the cord and brain; death being due to respiratory paralysis. The symptoms produced comprise a burning sensation with a feeling of constriction in the throat, nausea, vomiting, pain, oppression in the stomach and diarrhœa. The pupils dilate and the surface becomes cold; the respiratory movements become slower and feebler, and there may be delirium and coma. When the paralysis reaches the respiratory muscles the patient becomes cyanosed, and dies asphyxiated, death being frequently preceded by convulsions. The treatment consists in evacuating the stomach and administering stimulants along with the application of external warmth. Artificial respiration will be needed, and should be perseveringly kept up; by this means life may be saved when the condition appears to be hopeless. There are no characteristic post-mortem appearances—simply the indications of death from asphyxia.

FOXGLOVE.—This is a true heart poison; in fatal cases the heart usually ceases to beat before the respiration ceases, although the respiration-rate may be reduced in frequency shortly before death. In addition to the specific action of digitalis the poison acts as an irritant to the digestive canal, causing pain with a feeling of oppression about the stomach, nausea, often obstinate vomiting, and possibly diarrhœa, with colicky pains in the abdomen, and much thirst The specific effects of the poison are shown by giddiness, faintness, headache, clammy, cold surface, especially of the limbs, collapse, and various nerve disturbances such as dimness of vision, noises in the ears, hallucinations, and delirium. These symptoms are due to the extremely low arterial tension which is further evinced by the feeble, fluttering action of the heart; any movement towards the upright posture is immediately followed by threatened or actual syncope, which may be instantaneously fatal. The breathing is slow and of the sighing type. A tendency to drowsiness or to coma is common, and cyanosis with asphyxic convulsions may precede death.

Treatment.—Wash out the stomach or give a stimulating emetic such as a dessert-spoonful of mustard in warm water. As soon as the stomach is freed from the poison stimulants must be freely given, external warmth applied, and the recumbent posture rigorously maintained for several days. Friction and the application of mustard to the region of the heart, with the administration of hot coffee, to which brandy may be added, are helpful. If the vomiting is prolonged the coffee and the stimulants may be given by the rectum, or ether may be injected subcutaneously. An occasional fragment of ice will help to check the vomiting. It must be borne well in mind that the condition of the heart renders the patient extremely liable to fatal syncope for several days after the immediate effects of the poison have passed off; hence the absolute necessity for keeping him closely confined to bed until the dangerous period is passed.

The *fatal dose* of digitalis is uncertain: nine drachms of the tincture have caused death, and recovery has taken place after more than three ounces. Dangerous symptoms have been caused by the medicinal preparation called digitalin, which is an uncertain drug of no fixed chemical constitution, its activity being determined by the process by which it is prepared. In fatal cases of poisoning by foxglove death may take place within twenty hours, or it may be much longer delayed. There are no characteristic post-mortem appearances; some indications of the action of a gastro-intestinal irritant may be present.

COLCHICUM, in poisonous doses, causes a burning pain in the throat and down the œsophagus to the stomach, followed by copious vomiting and purging, with violent griping and strangury. There is intense thirst, with symptoms of collapse, the appearances being those previously described as due to a typical irritant poison. After the bowel-contents have been evacuated the alvine discharge becomes serous and may be blood-stained. Muscular spasms, or, occasionally, convulsions may occur. The mind usually remains clear until death approaches, although, exceptionally, stupor attacks the patient at an earlier stage.

The *treatment* consists in emptying the stomach by the tube or an emetic, and then giving strong tea and brandy, with friction, external warmth, and, if necessary, artificial respiration. If the vomiting be excessive an ether injection should be substituted for the brandy, unless the latter is administered by the rectum. A hypodermic injection of a third of a grain or half a grain of morphine will probably be required to allay the intense griping.

Fatal Dose.—Three and a half drachms of colchicum wine have caused death, and recovery has followed ten drachms. Six grains of colchicine—the active principle of colchicum—caused the death of an adult in thirty-one hours. Death from colchicum usually takes place within thirty hours; it has occurred as early as seven hours, and has been delayed for seven days. Beyond the possible presence of signs of inflammation of the intestinal mucous membrane there are no post-mortem appearances.

HELLEBORE contains a number of alkaloids of which one—*veratrine*—produces a very irritating effect on the nasal mucous membrane.

Symptoms.—An acrid, burning sensation beginning in the throat and extending to the stomach is quickly experienced, which is followed by vomiting and possibly by diarrhœa. There is great thirst, the pulse is feeble, the respirations are slow, and rapid collapse occurs. There may be disturbances of sensation and delirium.

Treatment.—Evacuate the stomach and administer hot coffee and stimulants. Artificial respiration, with the application of external warmth and friction, and the maintenance of the recumbent posture, may severally be required. There are no characteristic post-mortem appearances.

MONKSHOOD.—The alkaloid of this plant—*aconitine*—is probably the most virulent poison known. It most unfortunately happens that several preparations are known as aconitine, and that they differ enormously in potency. English and French aconitines are much more powerful than German aconitine.

Symptoms.—Tingling, followed by numbness, is felt in the lips, mouth, and throat soon after the poison is swallowed; the tingling subsequently spreads over all the body. Nausea, usually followed by vomiting and sometimes by purging, with pain in the stomach and abdomen, occurs. Imperfect vision, restlessness, anxiety, twitching of the muscles, darting nerve pains in the legs, prostration, feeble intermittent pulse, lowering of the temperature, and collapse with possibly convulsions, precede death.

Treatment.—Empty the stomach by tube or emetic. Administer brandy by mouth or rectum, or ether subcutaneously. External warmth, friction, artificial respiration, and the recumbent posture will be required.

Fatal Dose.—One drachm of aconite root, two grains of the pharmacopœial extract, one ounce of the liniment, and one drachm of the tincture have each caused death. The fatal period is from three-quarters of an hour to twenty hours; the usual period being from three to four hours.

The post-mortem appearances are not characteristic.

PILOCARPINE, the chief active principle of jaborandi, is used medicinally in order to promote the action of the skin. It also stimulates the secretion of mucus, and in this way occasionally produces symptoms of suffocation by causing sudden blockage of the bronchial tubes. One-sixth of a grain injected hypodermically has given rise to alarming symptoms. Vomiting, purging, and pain in the head are also produced. The effects may be combated by hypodermic injections of one-fiftieth of a grain of atropine.

PHYSOSTIGMINE, or ESERINE, an alkaloid of the Calabar bean, is used for ophthalmic purposes in order to contract the pupil. It has produced toxic effects when a stronger solution than usual has been dropped into the eye. When the bean is swallowed, pain in the stomach, vomiting, small slow pulse, salivation, thirst, cold moist surface, and occasionally diarrhœa, are produced. The *treatment* would be to evacuate the stomach if the poison was swallowed; to use artificial respiration if necessary, and to administer one-fiftieth of a grain doses of atropine until the pulse-rate is quickened. Hypodermic injections of strychnine, a fiftieth to a twenty-fifth of a grain, are useful.

SANTONIN occasionally produces symptoms of poisoning in children to whom it has been given as an anthelmintic. A common symptom, often seen without other ill effect, is what is called "yellow vision," probably due to primary stimulation with subsequent paralysis of the violet-seeing retinal elements. Singing in the ears, dizziness, pain in the stomach, vomiting, stupor, convulsions, and a tendency to asphyxia, may also occur. The urine is of a dark yellow colour, and, on the addition of sodium hydrate, becomes red. If rhubarb be present in the urine it yields the same reaction; but if milk of lime be subsequently added and the urine is filtered, the filtrate is colourless, whereas urine containing santonin does not lose its colour when similarly treated. Two grains of santonin caused the death of a child five and a half years' old; recovery in a child has followed ten grains. The treatment is to evacuate the poison, to give stimulants, and if convulsions occur, potassium bromide.

ABORTIFACIENTS

Among the substances which are taken by pregnant women with the object of procuring abortion are: savin, yew, pennyroyal, tansy, saffron, colocynth, croton oil, gamboge, aloes, hellebore, ergot, cantharides, phosphorus, and salts of iron, lead, mercury, and arsenic. With one exception none of these substances has a specific action on the healthy uterus, but abortion may follow their administration under one or both of two conditions: that there is an unhealthy relation between the uterus and its contents; or, that the drug is administered in such doses as to produce severe symptoms of general poisoning. It is well known that pregnant women suffering from syphilis, and from other conditions which are not well understood, abort very readily and from trivial causes; in such women a smart purge may induce abortion, so that with them many of the above-named substances, which are cathartics and irritants, are competent to cause abortion without being administered in poisonous doses. It is equally well known that perfectly healthy pregnant women may be subjected to considerable and even excessive violence from accidental causes without the progress of gestation being interfered with. Such women will not respond to any so-called ecbolics unless the drug is administered in sufficiently poisonous doses as to seriously derange the entire organism, often with fatal results. It not unfrequently happens, when powerful drugs are taken with the object of causing abortion, that the woman is fatally poisoned, and dies undelivered; in other cases abortion is speedily followed by the death of the mother. The inclusion of the salts of iron in the list of abortives is due to false deduction. Women know that doctors often prescribe iron in anæmic amenorrhœa, and have drawn the inference that the iron acts directly on the uterus, and compels it to resume its monthly function, and therefore that iron will re-establish menstruation which by any cause has been arrested. Even among medical men there is often an indefensible prejudice against the administration of iron to pregnant women; if, for the purpose of medicinal treatment, the health of a pregnant women calls for the administration of iron, there is no reason why it should not be given. Of the general poisons which indirectly cause abortion, two are exceptionally active —phosphorus and lead; with one exception the vegetable ecbolics are simply purgatives and irritants. The only substance in the list of ecbolics that, as such, merits discussion is ergot. This is a drug that undoubtedly is capable of acting directly on the uterus; it has, however, but slender claims to be entitled an abortifacient. In the later months of pregnancy, when uterine action has once commenced, the administration of ergot induces powerful tonic contraction of the uterine musculature, whether, at the moment, natural contraction is in progress or is not; but if ergot is given for the purpose of initiating labour it will probably not be successful unless it produces profound disturbance of the entire organism. In the early months of gestation (when criminal abortion is resorted to, the uterus at the time being passive) the administration of ergot is still less likely to induce uterine action, unless acute ergot poisoning is produced; and even then pregnant women have died from acute ergot poisoning (the drug having been taken for the purpose of inducing abortion) without abortion taking place.

The *symptoms of acute ergot poisoning* are: pain in the stomach, vomiting, a feeling of weight in the cardiac region, cramps, dyspnœa, numbness and tingling in the limbs, beginning at the fingers and toes, followed by extreme coldness, delirium, coma, and convulsions. Subcutaneous and submucous hæmorrhages, with the appearance of blood in the vomit and the motions, not unfrequently occur. The treatment is to empty the stomach and the bowels, unless the spontaneous evacuation has taken place. Stimulants and external warmth will be required. Inhalation of amyl nitrite or the administration of nitroglycerine by the mouth ($\frac{1}{100}$ to $\frac{1}{50}$ of a grain) may be tried.

Post-mortem Appearances.—The surface may be somewhat jaundiced, and there may be subcutaneous hæmorrhages. Extravasation of blood may also be found internally, on the surface and into the substance of the viscera. The liver and kidneys are often pale and bloodless, and they show the presence of fatty changes, sometimes very advanced, so much so as to give rise to suspicion of phosphorus poisoning. When ergot has been taken to produce abortion, the fœtus, on several occasions, has been found in the uterus after the death of the mother.

As regards abortifacients generally, the inference to be drawn is that there is no known drug which will infallibly induce abortion without imperilling the life of the mother.

POISONING BY FOOD-STUFFS

Many food-stuffs may become poisonous owing to partial changes in their composition, caused by the action of micro-organisms; others are hurtful by reason of the unwonted excess of a normal constituent.

VEGETABLE FOODS WHICH MAY CAUSE POISONING

Fungi (Mushroom poisoning).
Grain, especially rye (Ergotism).

Vetch (Lathyrism).
Maize (Pellagra).
Potato.

FUNGI.—Many fungi are inherently poisonous in the same sense that hemlock is; others, without possessing any essential toxic principle, occasionally act as poisons. The only fungi eaten in England are the common mushroom (*Agaricus campestris*) and the champignon (*Agaricus oreades*). On the Continent many other varieties are used as food. Fungi, being of extremely rapid growth, quickly undergo changes after being gathered which may convert those of a harmless variety into poisonous bodies; consequently, only fresh fungi should be eaten. Mushrooms which have been cooked should not be eaten after having been put aside and warmed up again.

The symptoms of fungi poisoning are *gastro-enteric* and *neurotic;* usually both occur, with relatively varying intensity, in the same patient. *Gastro-enteric symptoms* may not appear for eight or ten hours, or more, after the fungi are eaten. A painful sensation develops in the stomach and abdomen, and the latter becomes hard and tender; then follow nausea, vomiting, and diarrhœa; the motions may be serous, and may contain flakes of lymph and sometimes blood; the diarrhœa is often persistent. The other symptoms of irritant poisoning, tending to collapse, with occasionally jaundice, follow. *Neurotic symptoms* comprise muscular twitching, tetanic spasms, convulsions, delirium, disorders of vision, dilatations of the pupils, and coma. Sometimes the symptoms are exclusively neurotic; more frequently they are associated with gastric symptoms. The fly-fungus (*Amanita muscaria*), so-called because it acts as a fly-poison, causes delirium, clonic spasms, dilated pupils and quick pulse; in its mildest form the condition resembles that of alcoholic intoxication. The active principle of this fungus (*muscarine*) produces somewhat different symptoms, the assumption being that a second active principle, of antagonistic properties, is also present in the fungus. *Amanita phalloides* is another poisonous fungus, which, in addition to producing other symptoms, acts as a blood poison and causes fatty changes, especially in the liver, along with a hæmorrhagic tendency, closely resembling the effects of acute phosphorus poisoning. The fungus *Helvella esculenta* acts much in the same way.

Treatment of Fungi Poisoning.—Empty the stomach by means of an emetic, and the bowels with castor oil, and then treat the symptoms. External warmth and stimulants will be required, and morphine if the gastro-enteric symptoms are violent. If the symptoms partake of the muscarine type, atropine in one-twentieth of a grain doses may be given subcutaneously.

The *post-mortem appearances* vary in accordance with the action of the fungus; indications of gastro-enteritis with erosions and submucous hæmorrhages may be present, and the liver and other viscera may show fatty changes, which in the case of the liver may be very pronounced. If the symptoms during life were purely neurotic the post-mortem appearances will be indefinite.

ERGOTISM, or chronic ergot poisoning.—Ergot is the mycelium of a fungus—*Claviceps purpurea*—which grows on various species of grain, especially on rye. It is mostly met with in Russia and Germany, where, after a rainy summer, widespread epidemics of ergotism often occur, which are due to the inhabitants eating bread made from the diseased grain.

The *symptoms* commence with disturbance of the digestive tract;

nausea, occasional vomiting, a sense of oppression in the stomach, loss of energy, and either constipation or diarrhœa. Subsequently local symptoms manifest themselves, either in the form of gangrene, or of spasmodic contraction of muscles, with other nervous disturbances; both these types may occur in the same patient.

Gangrenous ergotism is initiated by patches of anæsthesia or by redness and burning of the skin, which is followed by gangrene, usually of the dry type, in the fingers and toes; this may spread as far as the elbows or knees, but the trunk is rarely affected. At the line of demarcation the gangrenous part separates by slow ulceration, unless it is removed by surgical operation. Very exceptionally the skin alone is attacked.

Spasmodic ergotism is preceded by various paræsthesiæ, such as a creeping sensation, beginning in the fingers and toes, or there may be anæsthesia, followed by spastic contraction of the muscles, by which the fingers and toes are drawn together and, along with the hands, are flexed—presenting the appearance of the clenched fist with the thumb drawn in towards the palm; the feet are extended, the heel being so powerfully drawn up as to cause the leg and foot to form a straight line. The dorsal muscles may also be contracted so as to produce opisthotonos. The spasms are excessively painful, and in the intervals the patient suffers from an unbearable burning pain in the affected limbs. The spasms may be tetanic in character, and the diaphragm may participate, so that respiration is impeded; sometimes the contractions are clonic, resembling epilepsy. Spastic contraction of the bladder, diplopia, deafness, aphasia, and changes in the visual field for colour, have been observed. The pulse is quick, and in the later stage is feeble. Psychical disorders, delirium, mania, stupor, and ataxic symptoms have been recorded; the knee-jerks are absent in these cases, and sclerosis of the posterior columns of the cord, implicating the root-zones, has been found. Both forms of ergotism are probably due to persistent contraction of the smaller arteries, which deprives the tissues implicated of their blood-supply.

The *treatment* consists in preventing further use of contaminated bread, and in dealing with the symptoms, medically and surgically.

LATHYRISM.—Several species of vetch—*Lathyrus sativus*, *L. cicera* (chick-pea), and *L. Clymenum*—may give rise to poisoning, cases of which have occurred in France, Spain, Africa, and India, through eating grain derived from one or other of the above-named species. The symptoms begin with pain and stiffness in the back, stiffness, with an intolerable creeping sensation in the limbs, tremor of the hands, and spastic gait; occasionally the gait is ataxic. The knee-jerk is exaggerated. Disorders of sensation, hyperæsthesia and paræsthesia followed by anæsthesia, may occur. Usually the legs only are affected; the arms, if at all, participate but slightly. But little is known of the morbid anatomy of lathyrism; the symptoms point to degenerative changes in the lateral columns of the cord; but any changes that take place cannot be very profound, inasmuch as after the grain is no longer eaten the symptoms usually subside in time, the course of lathyrism being much less severe and prolonged than that of the antecedently described disease—ergotism, or of the disease next to be described—pellagra.

PELLAGRA (*pelle*, skin, and *agra*, rough) is a disease produced by eating diseased maize, which in some countries is used as a substitute for corn. Pellagra is met with in France, Spain, Italy, Roumania, Austria, Corfu, Mexico, and Egypt. It occurs in the early part of the year and subsides in the autumn. It is rare in children.

General Symptoms.—Headache, depression, paræsthesiæ, cramps, vertigo, and dyspepsia, with the tongue denuded of epithelium, may precede the characteristic manifestations of the disease. These comprise erythema, with an œdematous condition of the skin, and an intolerable burning and itching on those parts of the body which are exposed to the sun. The acute stage lasts about a fortnight, when it subsides, leaving a dry, thickened, scaly, pigmented, psoriasis-like skin. The hair and nails are not affected. There is usually a recurrence each spring. After repeated attacks (not until after the third or fourth) the patient becomes melancholic; he suffers from delusions, and eventually from dementia. He may have epileptic seizures. The knee-jerk is exaggerated, ankle clonus is present, the condition resembling that of spastic paraplegia. Sensation is not affected. After many years the skin shrivels and the muscles atrophy; the knee-jerk is then lost.

The *morbid anatomy* comprises degeneration of the pyramidal tracts, mostly in the lower dorsal region; degeneration of Goll's column and also of Burdach's in the upper dorsal region, and there may be sclerosis of the lateral columns. Pigmentation of the anterior corneal cells has also been observed. In the very acute form of the disease diffuse myelitis is reported to have occurred.

POTATO, or *Solanum tuberosum*, has occasionally given rise to poisoning owing to the presence of an excessive amount of *solanine*, a poisonous constituent, especially of the seed-potato. It is probable, in cases of potato-poisoning, that the tubers which caused the mischief were sprouting, or that some young green potatoes were mixed with them.

The *symptoms* comprise frontal headache, colicky pains in the stomach and bowels, with swelling and tenderness of the abdomen, vomiting, diarrhœa, shivering, sweating, depression, slight stupor, oral and visual disturbances, congestion followed by pallor of the face, blueness of the lips, widely dilated pupils, initial acceleration with subsequent retardation of the pulse, elevation of temperature, syncope, and convulsions. In one case death took place on the third day.

The *treatment* is to clear the bowels of the potatoes and to give morphine, if necessary, along with stimulants and external warmth.

ANIMAL FOODS WHICH MAY CAUSE POISONING.—Meat, fish, sausage (botulism, or allantiasis), milk, cheese.

Meat, from a variety of causes, may injure the health of those who eat it. The animal from whence the meat is derived may have been the subject of parasitic disease, such as *Cysticercus cellulosæ*, which affects the pig; or the *C. bovis* of the cow; giving rise respectively to *Tenia solium*, and *T. mediocanellata* in man. The *Trichina spiralis* is another animal parasite which renders meat affected with it very dangerous to those who eat it, the disease produced being known as *trichiniasis.* This parasite is most common in pork—a meat that in various forms is often eaten in an imperfectly cooked state. The symptoms produced are: a feeling of general prostration, pain, vomiting, diarrhœa, elevation of temperature, and profuse perspiration, followed by symptoms due to the presence of the parasite in the muscles; local pain, tenderness, and swelling, with rigidity of the affected muscles. The early symptoms of trichiniasis sometimes resemble those of enterica; at others the onset is sudden, and the condition might be attributed to cholera or to irritant poisoning. Death, from ulceration of the intestine, from pneumonia, or from exhaustion, may result in four or five weeks, or earlier. The transmission of *anthrax* and of *tubercle* to human beings who eat the flesh of animals thus affected is a question that is still *sub judice.*

Apart from the specific conditions above described, meat may become dangerous as food: (*a*) from the presence of disease in the animal from which the meat is derived; (*b*) from micro-organisms which develop in the meat subsequent to slaughter; (*c*) from the presence of toxalbumoses or of ptomaines. The condition due to (*a*) and (*b*) is that of a true infection; that due to (*c*) is one of poisoning without infection. It might be supposed that the distinction between these two classes would always reveal itself—in the one case by a prolonged interval between the reception of the diseased meat and the commencement of the symptoms, and in the other by their rapid onset. Whilst it is true that in the cases of (*a*) and (*b*) a more or less prolonged period of incubation elapses after the meat is eaten before any indications manifest themselves, it is also equally true that in (*c*) the symptoms, though usually speedily developed, may be delayed for a considerable time.

The symptoms met with in (*a*) and (*b*) are those of an infectious disease. They include headache, anorexia, foul tongue, rigors, constipation followed by diarrhœa, pains in the back and limbs, elevation of temperature, photophobia, delirium, skin eruptions, meteorism, and enlargement of the spleen. The post-mortem appearances have a close resemblance to those of enterica —infiltration, ulceration, and sloughing of Peyer's patches, hæmorrhage into the bowel, enlargement of the spleen, with possibly depôts of pus. Sometimes the symptoms resemble those of the next group. The symptoms met with in (*c*) are those of acute gastro-enteritis—violent vomiting, purging, prostration, cramps in the legs, and collapse; the temperature is usually subnormal, but it may be elevated. The post-mortem appearances are those produced by gastro-enteritis, with hæmorrhages into the intestinal mucous membranes; the spleen is frequently enlarged, and Peyer's patches may be infiltrated.

Special symptoms occasionally ensue, such as dizziness, dryness of the mouth and throat, dyspnœa, heart failure. When a number of persons have eaten of the same poisonous meat they may not all suffer in the same way; not only may some of the victims be much more severely attacked than others, but the character of the symptoms may also differ in the various individuals.

The substances which cause meat-poisoning (*c*) are frequently spoken of as "ptomaines"; but, for the most part, they would be more correctly designated "toxalbumoses"; that is, proteid substances which have been acted on by bacteria in such a way as to develop intensely poisonous properties. Toxalbumoses are unstable, and their constitution is but little understood. Ptomaines—a later product of bacterial action—are basic substances which possess a definite chemical composition. A ptomaine may or may not be poisonous; many ptomaines are practically harmless. All these substances—toxalbumoses and ptomaines—when present in actively poisonous forms, are liable to lose their toxic properties as decomposition advances: a meat pie, for example, which caused severe poisoning in human beings, and which killed mice fed on it, after being kept a little longer became putrid, and at the same time lost its poisonous character, so that it could be eaten by mice with impunity. Poisonous bacterial products, though unstable, are sometimes very resistent of a high temperature—that of boiling water, for instance; so that cooking cannot be depended upon invariably to render the meat harmless. The same applies to micro-organisms and their spores that may be present in meat; the outermost layer of the meat may have its nocuous properties destroyed by boiling or roasting, but the central portion may never reach the requisite temperature.

Salting and smoking do not, or may not, remove poisonous properties that are present in the meat; neither does the exposure of the meat to a very low temperature, as in an ice-safe, necessarily inhibit bacterial decomposition. It is not essential that meat should acquire a suspicious odour in order to become poisonous; certain micro-organisms render meat dangerous without producing the ordinary accompaniments of decomposition. The kinds of meat which most commonly cause poisoning are: pig's flesh, veal, beef, various kinds of meat pies, potted meat, tinned meat, sausages, and brawn.

Allantiasis or *botulism* are names given to sausage-poisoning, due to eating "German sausage," which consists of finely divided meat mixed with other substances, imperfectly cooked, and frequently formed into large masses. A bacterial decomposition product, endowed with special toxic properties, is not unfrequently formed, to which the name *ptomatropine* has been given on account of a certain resemblance between the symptoms it produces and those produced by atropine.

The *symptoms* of allantiasis do not usually develop for from twelve to twenty-four hours after the poisonous sausage has been eaten. The patient has a foul tongue, with dryness in the throat and suppression of the salivary secretion, which causes the voice to be hoarse and the swallowing to be difficult or impossible; there may be a dry laryngeal cough. Nausea and vomiting with diarrhœa, or perhaps obstinate constipation with colic, follow. The pulse is rapid, the pupils are dilated and reactionless, and there may be ptosis and diplopia. Affections of the special senses, as sounds in the ears and dizziness, are frequent. In fatal cases death occurs in four or five days; occasionally its occurrence is earlier. There are no characteristic post-mortem appearances. The *treatment* is to evacuate the bowels and stomach, if this has not previously been done spontaneously, and to give hypodermic injections of pilocarpine hydrochlorate (one-third to half a grain), the patient being enveloped in blankets wrung out of hot water.

FISH.—Some fish are inherently poisonous; they are mostly found in tropical waters; others, such as mackerel, carp, barbel, and herrings, are liable to become poisonous; mackerel and herrings are especially prone to develop poisonous properties after they are caught. Something depends on the treatment of the fish; herrings, if they are not "gutted" immediately after they are removed from the water, quickly become unfit for food. Caviare, the roe of herrings and of other fish, dried cod-fish, preserved anchovies and sardines, have caused poisoning; a stale red herring caused the death of a man from gastro-enteritis. Shell-fish excepted, mackerel produces the greatest number of cases of fish-poisoning in this country. The symptoms of fish poisoning may be purely gastro-enteric, or they may be partially or entirely neurotic—swelling of the tongue and face, intense itching of the skin, coldness of the hands and feet, thirst, dyspnœa, and convulsions. Tinned salmon and sardines have caused fatal poisoning, the post-mortem appearances indicating the action of a most potent irritant; in one case the stomach and intestines were so intensely inflamed as to be almost gangrenous. Sometimes the mischief produced is of such a character as to indicate the action of micro-organisms rather than of a pre-formed poisonous substance.

SHELL-FISH, as mussels and oysters, may, during the lifetime of the fish, develop toxines which render them poisonous. This occurs if the fish are placed in stagnant water, especially if it is contaminated by decomposing organic matter; so that mussels obtained from docks, harbours, the mouths of rivers, or other places where there is a restricted tidal interchange, are liable to be poisonous; indeed almost all the bad cases of mussel poisoning are due to this cause. A mild form of mussel-poisoning is characterised by the appearance of an urticarial or an exanthematous eruption on the body, often associated with oppression in the chest and difficulty of breathing; these symptoms usually pass off in a short time. In the severer forms there is gastro-enteritis, and in the most dangerous of all, paralysis. A man ate uncooked a large quantity of mussels obtained from the bottom of a graving dock; he became unconscious and livid, with imperceptible pulse and widely dilated pupils, paralysis of the limbs, and slow, gasping respirations once or twice in the minute, death taking place in twelve hours from respiratory paralysis; the heart continued to beat for many hours after voluntary respiration had ceased. In this case there was neither vomiting nor purging. Death may occur very rapidly without any post-mortem indications. A man ate some mussels and very soon after his face became fiery red and he died in an hour; at the autopsy no signs of gastritis were found, nor was there any obvious cause of death. Oysters also, under the above-named conditions, may develop toxines, which may produce either gastro-enteric or purely neurotic symptoms, or a combination of the two. In the neurotic type of shell-fish poisoning death takes place from respiratory paralysis. In addition to causing poisoning shell-fish may convey disease. Oysters and mussels which have been placed in water contaminated with sewage containing typhoid bacilli are capable of communicating enterica to those who eat the fish in a raw state.

Milk may give rise to illness, either by being contaminated with pathogenic micro-organisms, or from the formation in it of decomposition products. Instances of the first-named group have occurred in which the milk was found to contain streptococci, and bacilli of the type of *B. coli commune*, which caused an outbreak of disease chiefly among children who had been fed with the milk. In other instances milk has conveyed typhoid fever, either on account of the milk-cans having been washed with germ-laden water, or by transference of germs to the milk from the hands of dairymaids who were nursing cases of typhoid fever. Cows are subject to a number of diseases which may render their milk dangerous to human beings. When milk is thus contaminated it is by no means easy to destroy the germs by subjecting the milk to heat; the spores of many micro-organisms resist a temperature of 212° F. maintained for three-quarters of an hour or more; some anaerobic bacteria are even still more resistent.

When milk, derived from healthy cows, is not cooled immediately after milking, especially in hot weather, it is liable to develop early decomposition products which produce nausea, vomiting, cramps, diarrhœa, and collapse. By exposing the milk, warm from the cow, in shallow basins surrounded with cold water or, if necessary, with ice, this danger may be avoided. The greatest risk is incurred when the warm milk, in hot weather, is conveyed to a distance by cart and rail; the continuance of an elevated temperature along with the constant agitation to which the milk is subjected are very liable to promote changes which lead to the formation of toxic products.

The *ice creams* which are sold in the streets not unfrequently cause illness on account of the decomposition products they contain. In some instances children that have eaten such creams are attacked with symptoms which closely resemble those of meningitis—restlessness, dulness, insensibility, and retraction of the head; the symptoms usually subside within forty-eight hours. In other instances these ice-creams are profusely contaminated with micro-organisms, some of which may be pathogenic; this is due to carelessness and to the extreme insanitary conditions under which such creams are frequently made.

CHEESE.—Instances of poisoning by cheese have occurred from time to time; the symptoms produced being: pain in the stomach, violent vomiting, diarrhœa, and cramps in the legs; the tongue, at first coated, becomes red and dry; the pulse is weak and irregular, and the face is pale and cyanotic. Old, decayed cheese has caused colic, diarrhœa, diplopia, precordial pain, and collapse.

The poisonous agent in cheese has been variously described as *tyrotoxicon*, a substance which closely resembles diazobenzene; as a toxalbumose, and as a tertiary amine—trimethylamine.

Trachea, Affections of the.

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MALFORMATIONS.—The chief malformations to which the trachea is liable are:—

1. The trachea is short and imperforate.
2. The trachea communicates with the œsophagus.
3. Fistula, by which the trachea communicates with the surface of the neck.

TRACHEITIS.—The two chief varieties of inflammation of the trachea are:—

1. Catarrhal tracheitis.
2. Diphtheritic tracheitis.

Catarrhal Tracheitis.—This is often associated with a similar condition in the larynx or bronchial tubes.

Causation.—Sudden alterations in the temperature of the air, the breathing of irritating vapours, and chill, are the most common exciting causes.

Morbid Anatomy.—There is swelling with hyperæmia of the mucous membrane. In severe cases ulceration even may be present.

Symptoms.—In acute catarrhal tracheitis there may be elevation of temperature with quickened pulse, while the patient complains of a tickling sensation in the trachea and of substernal pain. Cough is one of the most prominent symptoms, and is most marked when the patient lies down. It is at first dry and accompanied by very little expectoration, but afterwards the sputum becomes more abundant and more purulent. Nothing abnormal is heard by auscultation over the trachea.

Diagnosis.—This depends on examination. Thus, with the laryngoscope the presence of an accompanying laryngitis will be confirmed or contradicted, while if the glottis be widely open and a good view obtained, hyperæmia of the tracheal mucous membrane will be seen. By examination of the chest the presence or absence of bronchitis will be diagnosed.

In chronic catarrhal tracheitis there is little or no constitutional disturbance; but there are present a constant feeling of irritation in the trachea, with cough. The same physical examination must be made as in the case of acute affection.

Treatment.—At the commencement of an attack of acute catarrhal tracheitis the patient should, if possible, be put to bed and an aperient, preferably calomel, followed by a saline. Given at this stage good results follow the administration of ♏xx. doses of vinum antimoniale, and, if there is much substernal pain, hot linseed poultices over the front of the chest give relief. The cough is best relieved by the frequent inhalation of the steam from a pint of hot water to which ʒj. of compound tincture of benzine has been added. As expectoration becomes more profuse and the cough loose, it is well to give a mixture containing ipecacuanha, iodide of potassium, ammonium carbonate, and senega. In the chronic condition tonics, such as iron and quinine, are indicated, and the patient should, if possible, have change of air. In obstinate cases a blister over the sternum is of great service.

Diphtheritic Tracheitis.—This nearly always occurs as an extension downwards of laryngeal diphtheria, but the deposit of diphtheritic membrane in the trachea is sometimes primary (*v.* article "DIPHTHERIA").

ULCERATION.—The varieties of tracheal ulceration are:—

1. *Simple ulcers* may form in the course of catarrhal tracheitis, and are caused by swelling and breaking down of the masses of lymphoid tissue.

2. *Syphilitis.*—In secondary syphilis mucous patches and superficial ulcers may form, but their presence will not usually be diagnosed.

In tertiary syphilis deep ulcers may form, and may cause necrosis of the cartilaginous rings. These ulcers heal under potassium iodide, but in their healing contract, and so cause a serious amount of tracheal stenosis. The lower part of the trachea is most commonly thus affected.

Symptoms.—The symptoms are those of chronic tracheitis. There is no sputum at first, but this afterwards becomes plentiful, muco-purulent, and streaked with blood. If situated high up the ulcers may be seen with the laryngoscope. The diagnosis generally depends on:—(*a*) The patient's history; (*b*) The presence of other lesions of a syphilitic nature; (*c*) The absence of tubercle bacilli from the sputum.

Treatment.—Give potassium iodide and a linctus, *e.g.* morphinæ hydrochlor. gr. $\frac{1}{24}$, syrup of balsam of tolu, and acid infusion of roses, āā ʒss.

3. *Tuberculous.*—These occur in advanced cases of pulmonary and laryngeal phthisis (*v.* articles on those subjects).

PERFORATION.—This may arise:—

1. From bursting of an aneurysm. This is immediately fatal.

2. From bursting of an abscess into the trachea. This may cause death from asphyxia if the abscess is large. If this accident is not immediately fatal the treatment indicated is to provide a free external drain for the abscess.

TUMOURS.—Tumours of the trachea are uncommon, many of them extremely so. Elsberg classifies them thus:—

1. Benign
    - Papilloma; most common.
    - Fibroma.
    - Enchondroma.
    - Osteoma.
    - Myxo-adenoma.
2. Malignant
    - Carcinoma.
    - Sarcoma.

The benign tumours of the trachea have attention called to them by the occurrence of permanent difficulty of breathing, or of passing attacks of dyspepsia. For diagnosis see remarks on Tracheal Stenosis.

Treatment.—If situated high up, a papilloma of the trachea may be removed by the endo-laryngeal route. If low down, tracheotomy must be done, and the tumour, if possible, removed through the tracheal wound.

Tracheal carcinoma practically always occurs by extension from surrounding structures.

Tracheal Obstruction.—*Causes.*—1. Stricture of the trachea from cicatricial narrowing of its wall, generally syphilitic.

2. A tumour within the trachea.

3. Pressure from without, *e.g.* by a thoracic tumour or aneurysm, by an abscess, by an enlarged thyroid gland, or by a dislocated clavicle.

Symptoms.—There is an obvious obstruction to respiration, and stridor is present. Inspiration is more noisy and more prolonged than expiration. The larynx moves up and down little, if at all, during respiration; while in laryngeal obstruction the larynx moves up and down freely. In extreme cases the lips have a bluish tinge, and the patient uses forcibly both the ordinary and the extraordinary muscles of respiration. By auscultation over the trachea a high pitched whistling sound is heard. The voice may not be affected at all. It may, however, be faint and weak; but this quality must be distinguished from the hoarseness generally present in cases of laryngeal obstruction. However, in a case of tracheal obstruction the voice may be hoarse, as pressure on the trachea is often accompanied by pressure on one or both recurrent laryngeal nerves.

These chronic symptoms may be associated with paroxysms of severe dyspnœa, which may be due to swelling of the tracheal mucous membrane, or to double abductor laryngeal paralysis due to pressure on both recurrent laryngeal nerves.

Diagnosis.—A laryngoscopic examination must be made, the presence of laryngeal obstruction being thus excluded, and the presence of a tumour or stenosis high up in the trachea perhaps diagnosed. Next the thorax must be examined for signs of the presence of an aneurysm and for signs suggestive of chronic mediastinitis. The neck, too, must be examined for evidence of aneurysm or tumour, and an œsophageal bougie should be passed. If the investigation of these parts has a negative result, then the obstruction must be in the trachea and due to contraction of its wall or an endo-laryngeal tumour. In the case of the former there will probably be a history of syphilis, while the latter may possibly be detected with the laryngoscope.

Treatment.—In many cases treatment is of no avail; in others a tumour pressing on the trachea has to be removed or an abscess evacuated; while in a third class, *e.g.* tracheal stenosis, treatment is possible, though often unsatisfactory. For stricture high up in the trachea a low tracheotomy should be done. Stricture low down in the trachea has been treated by passing flexible tubes through tracheotomy wounds.

Rupture.—Rupture of the trachea is very rare.

Causation.—Direct violence applied over the trachea.

Symptoms.—Obstruction to respiration, swelling over the front of the neck. General emphysema is generally rapidly fatal.

Treatment.—Expose the trachea by a free median incision, clear away blood-clot. If the ends of the trachea are widely separated suture them together. Put in a tracheotomy tube.

Wounds.—*Varieties.*—1. Incised wounds, *e.g.*, in cases of cut-throat.

2. Gun-shot wounds.

In the former the edges of the superficial wound should be left widely open, while the edges of the tracheal wound, if widely separated, may be sutured. Gun-shot wounds often result in tracheal stenosis.

Foreign Bodies in the Trachea.—*Symptoms.*—At the moment the body is drawn through the larynx there is a violent attack of dyspnœa due to spasm of the glottis; but when the body has dropped into the trachea the urgent symptoms subside. The absence of symptoms is only temporary, for directly the body is coughed into the larynx again, another spasm of the glottis occurs, with resulting obstruction to respiration.

Treatment.—When the history is given of recurrent acute attacks of dyspnœa, with free intervals following the supposed entry into the air passage of a foreign body, tracheotomy should be at once done. The edges of the tracheal wound being held widely apart, the body is as a rule coughed into view and can easily be removed. If not at once seen, it should be searched for with forceps, and if it is still not found a tracheotomy tube should be inserted, and the trachea further explored on another occasion.

TRACHEOTOMY.—*Indications for the Operation.*—1. The presence in the larynx, pharynx, or upper part of the trachea of a serious obstruction to respiration, *e.g.* :—

(*a*) Diphtheritic membrane.
(*b*) Tumour of larynx or trachea.
(*c*) Œdematous laryngitis.
(*d*) Double abductor laryngeal paralysis.
(*e*) Cicatricial adhesion of the vocal cords.

2. Foreign bodies in the trachea.

3. As a preliminary to certain operations, *e.g.* removal of the tongue.

Varieties of Operation.—1. The high operation, in which the trachea is opened above the isthmus of the thyroid.

2. The low, in which the trachea is opened below the isthmus. The former operation is usually done.

Position of the Patient.—The patient should be on a narrow table in a good light. There should be a small pillow beneath the shoulders, so that the head is stretched back, and the chin should be kept accurately in the middle line.

The Operation.—The usual precautions as to asepsis having been taken, and the skin being steadied with the fingers of the left hand, an incision 1½ in. long is made accurately in the middle line of the neck with its upper end just overlapping the cricoid cartilage. The skin and fat being rapidly divided, the layer of deep cervical fascia overlying the pre-tracheal muscles is seen and divided. Beneath this fascia the anterior jugular veins run down on either side of the middle line, and there may be a communicating branch across the middle line. The interval between the sterno-hyoid and sterno-thyroid muscles of the two sides is then recognised in the middle line, and the muscles are separated and held apart with retractives. The finger should now be put into the wound and the trachea felt for, and steadied between the thumb and fingers of the left hand. The deep cervical fascia over the front of the trachea is now to be cleanly divided in the middle line, and the thyroid isthmus, which lies over the second and third rings of the trachea, pulled down with a blunt hook. Distended veins may be encountered at this stage, and should be clamped or drawn aside. The rings of the trachea being clearly exposed, a sharp hook is introduced into the middle line of the trachea just below the cricoid cartilage, and the air-passage pulled a little upwards and forwards. Then with a small scalpel the operator sharply plunges into the middle line of the trachea at about the third costal cartilage and cuts upwards. The rush of air into the trachea is now heard, and the tracheal dilator is immediately introduced and the blades opened. The tracheotomy tube is next introduced in the following way:—With the right hand hold the dilator in the trachea with its blades apart. Take the outer tube in the left hand, press its two halves together, and introduce it slowly and carefully into the trachea between the opened blades of the dilator. As soon as it is certain that air is passing in and out through the tube, remove the dilators while the tube is held securely in position. Then tie the tapes round the neck and introduce the inner tube.

If the low operation is being done the incision must be nearer the sternum, and the thyroid isthmus pulled upwards. Difficulty may arise from the inferior thyroid veins on the front of the trachea and from the occasional presence of the thyroidea ima artery running up the middle line of the trachea.

Comment on the Operation.—1. It is impossible to describe here all the varieties of tracheotomy tube. The most generally useful one is the ordinary bi-valve tube with a movable shield.

2. The chief difficulties likely to be met with are:—

(*a*) The patient may be an infant with a short, fat neck. This converts what is otherwise an easy operation into a difficult one, for the trachea is deeply situated, and the room for manipulation is limited. If the cardinal rules—to make a long enough incision, to cut accurately in the middle line, and not to open the trachea till its rings are recognised—are observed the difficulty is reduced to a minimum.

(*b*) Distended veins may be found crossing the line of incision. These should, as far as possible, be secured and divided between forceps; but too long a time should not be spent in arresting venous bleeding, for this will cease as soon as the trachea is opened.

(*c*) In young fat children there is very little space left above the thyroid isthmus. In this case the isthmus should be divided in the middle line. The bleeding will be slight, and can at once be stopped by applying forceps to each half of the isthmus.

(*d*) The tube may be introduced between the pre-tracheal fascia and the trachea. To avoid this divide the fascia freely enough, and introduce the tube carefully and without hurry.

(*e*) One limb of the outer tube may be put into the trachea, and one between the trachea and the fascia. This is avoided if ordinary care is taken. The two last occurrences are recognised by the fact that no air passes through the tube, in which case the tube must be taken out and reintroduced.

After Treatment.—The patient should be in a bed surrounded by curtains, and in a temperature of from 62° to 65° F. A steam tent may be used, but is not necessary. A covering of six or eight layers of gauze should be kept over the tube and frequently renewed.

Membrane or secretion coughed up through the tube is to be caught on a mop, and must on no account be allowed to slip down the tube again.

The inner tube should be removed whenever it becomes blocked, and, under any circumstances, once every two hours at least. Before being put back it must be cleaned by boiling in soda solution.

Nourishment must be given frequently. Blunt hook retractors, tracheal dilators, and an extra tube must always be at hand.

On the fifth or sixth day an attempt should be made to leave the tube out. When this is done the surgeon should be near at hand for some time, as the tube often has to be replaced.

The remarks in this article apply chiefly to the operation when done for diphtheritic laryngitis. When it has been done for some conditions, *e.g.* growths or stenosis of the larynx, the tube may, of course, have to be worn permanently.

Difficulties met with in attempting to leave out the Tube.—1. *Fright.*—

For a few minutes after removal of the tube the patient breathes through the tracheal wound, and directly the edges of the wound fall together the child feels the slight obstruction to inspiration and becomes frightened. A spasm of the glottis occurs, and the tube has to be replaced. This may occur several times.

Treatment.—Use a tube with an opening on the convexity, plug the outer end of the tube, and the patient unconsciously breathes through the larynx, and the tube can be removed.

2. Granulations may form in a mass at the junction of the trachea and larynx, or in the trachea on a level with the wound.

Treatment.—Use a well-fitting tube with a movable shield, and leave it out as soon as possible. If granulations should form touch them with silver nitrate. It may be necessary to frequently pass a flexible tube from the wound up through the glottis.

3. Stenosis of the larynx, varying from partial adhesion of the cords to complete blocking. In the former case dilate the rima-glottidis after division of the cicatricial tissue. In the latter thyrotomy must be done, and the cicatricial tissue cut away. In both conditions relapse is frequent, and so the tube has to be permanently worn.

4. Impairment of function of the laryngeal muscles, which may take one of the following forms:—

(*a*) Diphtheritic paralysis of the laryngeal muscles, which is more prone to affect the abductors of the cords than the adductors.

(*b*) The wearing of the tube interrupts the normal rhythm between the actions of the laryngeal muscles and those of inspiration.

In both these conditions the treatment is to wait, for the muscles will regain their functions in time.

5. In one instance, in which it was found impossible to leave out the tube, the writer found that the trachea was compressed by a large amount of cicatricial tissue formed round the tracheotomy wound.

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Trades, Dangerous.

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LEAD-POISONING

SYNONYMS.—Plumbism; Saturnine Poisoning; Painters' Colic; Colica Poitou; *Fr.*, Intoxication Saturnine; *Germ.*, Bleivergiftung.

OF all forms of metallic poisoning that caused by lead is far and away the commonest, owing to lead being so widely used in the arts and in commerce. The peculiarity of lead-poisoning is that it may develop so insidiously that a person is sometimes precipitated into a state of serious ill health without much warning.

The causes of plumbism may, roughly speaking, be regarded as three: accidental, industrial, and self induced. Under accidental poisoning are to be included those cases in which plumbism has been caused by drinking water that has become contaminated either through being stored in a lead cistern or through having lain overnight in the conduit-pipe that leads from the main into the interior of the house, through eating canned food that has become adulterated in consequence of the acid juices having acted upon the solder, also through eating food that has been cooked in cheap enamelled pans. A few cases, too, can be traced to the use of certain hair-dyes. Under the head of industrial lead-poisoning must be included a variety of trades, *e.g.* the smelting of lead, the manufacture and packing of red and white lead, dye works using chrome or yellow lead compounds, house and coach painting, electric accumulator works, plumbing, manufacture of pottery, file cutting, glass polishing, etc. Self-induced lead-poisoning is generally due to lead having been taken, not with the view of causing death suicidally, but to induce abortion in pregnancy.

Accidental lead-poisoning is mostly due to drinking contaminated water. Under such circumstances the malady assumes almost an epidemic character. In a town or locality several people are found to be suffering at the same time from plumbism. Certain waters are known to exercise a greater solvent influence upon lead pipes than others. Water that is soft and of moorland origin owing to the presence therein of free acid that has been generated during the decomposition of peat, also water that contains iron, are capable of dissolving out a sufficient quantity of lead from the pipes to cause in a very short time symptoms of such severity as to threaten life or to incapacitate the individual for weeks, or even months. Several towns in Yorkshire have within the last few years suffered from plumbism traceable to this source. The addition of unburnt lime or of magnesian limestone to the filter-beds, or allowing the drinking water to gravitate through layers of sand, confers upon the water that degree of hardness, or gives to it such salts as carbonates and silicates, whereby an insoluble coating is deposited on the inside of the pipe which, in the absence of free carbonic acid, forms a protective covering.

It is to the numerous industries that we look for the largest number of cases of lead-poisoning, and among these the manufacture of red and white lead, manufacture of certain kinds of pottery, and the occupation of house-painting may be specially mentioned. In Britain the getting of the raw ore is not attended by any risk to the miner from plumbism, but at the Brocken Hill mines in Australia, where the ore exists very largely in the form of carbonate, there has been much sickness among the miners due to lead. In Britain the danger commences with the smelting of the lead ore. There is little risk from the manipulation of metallic lead compared with that incurred by the handling and inhalation of lead compounds. The more soluble these compounds are, the greater is the danger. Among the recognised dangerous compounds may be mentioned the red oxide, carbonate or white lead, acetate, and chromate. In any industry in which these salts of lead are made or handled the workpeople, unless they are particularly careful, run the risk of losing their health sooner or later. In the manufacture of pottery the earthenware is glazed by being dipped in a composition that contains a large quantity of lead carbonate or oxide. When the ware is dried and is being cleaned or brushed there is given off a considerable amount of dust, the inhalation or swallowing of which induces plumbism. Lead compounds, too, are used for colouring pottery, and especially for what is known as majolica ware. Workers in pottery are, in many ways therefore, exposed to the risk of lead-poisoning. The frequency of lead-poisoning, too, in house painters has conferred upon the malady, through one of its symptoms, the name of painters' colic. Within recent years several new industries have developed. Of these the one that is specially productive of plumbism is the manufacture of electrical batteries for telegraph and telephone purposes. In the manufacture of these batteries perforated lead plates are used. The openings in the grid have to be filled by a composition that looks like red clay, but which is a mixture of red oxide of lead. During the mixing of the dry powders that form the composition a considerable amount of dust rises and is inhaled, and during the rubbing of the paste into the openings in the plate, which is usually done by the hands encased in india-rubber gloves, some of the paste, owing to a tear in the gloves, gets rubbed into the skin and causes plumbism. Of the other trades risky to health from the handling of lead or its compounds may be mentioned file-cutting by hand, house and coach-painting, the dyeing of wool by means of chromate of lead, and, especially on the Continent, the handling of type by compositors for printing newspapers, etc. In Britain and America newspaper printing is now so largely done by means of the linotype machine instead of by hand-set type, that while linotyping is not absolutely free from the possibility of lead-poisoning, the risk is so extremely small compared with that incurred by setting up the type by hand that the two methods can scarcely be contrasted. In hand-file cutting and in pottery manufacture in addition to the risks from plumbism the death-rate from pulmonary phthisis is extremely high, owing to the dusty nature of the occupation.

In addition to the accidental and industrial forms of lead-poisoning, allusion has been made to that which is self-induced. Lead salts are very rarely resorted to for suicidal purposes; but as lead is known to possess distinctly ecbolic properties, the ignorant often have recourse to diachylon pills for the purpose of procuring abortion. Self-administration of the pills has in the Midlands, where the practice is more prevalent than in other parts of England, caused death in some instances, and in others induced such serious symptoms as paralysis and loss of vision.

Of the sexes females are, I think, on the whole more susceptible to lead than males, so too are young persons and all who are ill-nourished, anæmic, and intemperate in the use of alcohol.

The channels by which lead effects an entrance into the system are the alimentary canal and respiratory passages, and also the skin. Workers in white lead not only inhale the dust, they swallow it. When they eat their food with unwashed hands the lead which is swallowed becomes dissolved by the hydrochloric acid of the gastric juice, and is converted into a soluble chloride, some of which may be absorbed as chloride, or it may be converted into an albuminate, while a large quantity escapes by the fæces in the form of sulphide. That lead is capable of entering the system through the skin has been demonstrated by the use of cosmetics and hair-dyes that contain lead. When the poison is circulating in the blood symptoms of acute plumbism show themselves, often on the side of the nervous system; but there is a tendency for the metal to be deposited in the tissues probably in the form of the rather insoluble albuminate. In several of my fatal cases of plumbism, Dr. Bedson, Professor of Chemistry in the University of Durham College of Science, extracted from the liver, kidneys, brain, and muscles, lead in varying quantities. The poison is unevenly distributed throughout the body, but in my own cases the liver was the organ that generally contained the largest quantity of lead.

Symptomatology.—One of the earliest signs of a white lead worker becoming poisoned by lead is a peculiar *pallor* of the countenance. Probably for several weeks the friends of the workman have noticed that he has been losing the ruddy appearance of health. Not only does the face become pale, but the features tend to become expressionless. There is a peculiar fulness, too, in the lower half of the face. On examining the blood microscopically it is noticed that there are fewer red corpuscles than in health, and that the hæmoglobin is proportionally diminished, while the number of leucocytes remains about the normal. Since lead is often found in the bones after death, the probability is that the function of bone marrow as a blood-cell-forming agent is seriously impaired early on in the course of plumbism. Sometimes without any very marked, but usually with a considerable degree of pallor, the worker is gradually or suddenly seized with acute *pain* in the abdomen, which is referred to the neighbourhood of the umbilicus just above or to either side of it. The pain is sometimes so severe that he writhes in agony. He can allow nothing to touch his abdomen. In other instances not only is pressure well borne but relief is obtained by the patient placing a pillow on the back of a chair and leaning all his weight upon it. Accompanying the pain there is often vomiting and a considerable amount of restlessness. Usually the bowels are obstinately confined, but instead of constipation there may be diarrhœa. The abdomen may be retracted, but not necessarily so. During the attack of colic, sulphocyanides disappear from the saliva to reappear on cessation of the pain. The cause of lead colic has not been definitely determined. The character of the pain is suggestive of spasm, and it is therefore probably due to extreme peristaltic contraction of portions of the small intestine. In animals poisoned by lead I have found the small intestine so firmly contracted at places as to have its calibre completely obliterated, while the intervening portions were either normal or very slightly dilated. The pain therefore might be due to the distended portions of the intestine trying to send on their contents into the portions spasmodically contracted, or be due, as is more probable, to the spasmodic contraction itself. It is difficult to say whether lead acts primarily upon the muscular fibre of the bowel, or upon the sympathetic ganglia and nerve-fibres. During colic the radial pulse is small, slow, and feeble; it may fall to forty beats in the minute. At other times the pulse is one of high tension, and the two radial pulses are unequal. The urine is scanty; sometimes only eight or ten ounces are passed in the day. In uncomplicated cases it is free from albumin, but albumin may be present, persist through the colic in some patients, and disappear with it. This temporary albuminaria may be due to irritation of the renal epithelia by the toxic blood, or it may be that it marks the commencement of a parenchymatous nephritis, which becomes confirmed as time goes on, and ultimately ends in the development of contracted kidney. Frequently lead colic has been mistaken for appendicitis, and *vice versa.* The question has been sometimes raised as to whether poisoning of the musculature of the bowel by lead may become a cause of appendicitis. Certainly a patient suffering from lead colic can develop an appendicitis; but even under these circumstances I should regard intestinal micro-organisms as the more probable cause of the appendicitis. It is not always easy to distinguish between lead colic and inflammation of the appendix. As a rule lead colic only lasts two or three days, the pain is referred to a part higher up in the abdomen than the seat of the appendix, there is more sickness, also an absence of the elevated temperature observed in appendicitis. On examining the gums there is usually to be seen a *blue line* close to the margins of the teeth, especially noticeable where the teeth are decayed. Such a line, although corroborative evidence of plumbism, is not a proof of lead-poisoning being present at the time of its detection by the medical practitioner, for a blue line may for months be seen on the gums of lead-workers without these persons presenting any symptoms of lead-poisoning at all. It indicates that lead is in the system. This blue line, which was first described by Burton, is due to the deposition of particles of sulphide of lead in the deeper epithelial cells of the gums, and particularly in the large connective-tissue cells situated in the ulcerated portion of the gums. Where there are no teeth there is no blue line, and where work people are in the habit of using the tooth-brush regularly it may be absent. This circumstance suggests that the coloured line is due to the decomposition of particles of food that have been arrested between the teeth, the development therefrom of sulphuretted hydrogen, and the reaction of this gas upon lead salts in solution, and the deposition of the insoluble black sulphide in the interior of the cells. Many of my patients have had large bluish black patches the size of a sixpenny piece or larger, inside the lower lip or on the mucous membrane of the cheek, usually opposite a decayed tooth. At autopsies I have found similar large patches in the mucous membrane of the small intestine.

A common sign of lead-poisoning is *wrist-drop*. In plumbism, as in all forms of paralysis due to poisoning, the loss of power is bilateral. Although the wrist-drop is double, one hand is usually more affected than the other. In some instances muscular strain predisposes to the paralysis, but apart from this circumstance, lead itself, quite irrespective of the manner in which it has gained an entrance into the system, is capable of causing the loss of power. The paralysis affects the extensors of the fingers and wrists. Often the index finger escapes. In other instances, both it and the little finger as well as the thumb cannot be extended, nor can the fingers be separated from each other owing to paralysis of the dorsal interossei. What strikes an observer in regard to the double wrist-drop is the utter helplessness of the patient. The hands fall powerless by his sides. The patient cannot raise a hand unless he places the other underneath it, nor can he pick up anything. Any attempt to extend the fingers and wrists induces marked tremor of the muscles generally, including the flexors, which in time also suffer from loss of power. Preceding the paralysis, which may have been gradually or quickly developed, there is sometimes experienced by the patient a sense of tingling or of numbness, but only very occasionally is actual pain complained of. Even when there is pain it is never so severe when the affected muscles are grasped as in peripheral neuritis, due, for example, to alcohol. The muscles sooner or later begin to atrophy. One of the characteristic features of wrist-drop due to lead is that, while the extensors of the fingers and wrists are paralysed, the supinator longus, which is supplied by the same nerve, viz. the musculo-spiral, is not affected. In addition to wrist-drop, two other forms of paralysis are met with. (1) The

Duchenne-Erb type in which the deltoid, biceps, brachialis anticus and supinator longus are affected—a form of paralysis that is usually severe and (2), the *Aran-Duchenne* type, in which the small muscles of the fingers, *e.g.* thenar, hypothenar, and interossei are affected. The appearances presented by this latter type resemble progressive muscular atrophy, only there are not the fibrillation and muscular tremor, nor the rapid loss of substance so noticeable in progressive muscular atrophy. In severe cases of plumbism the paralysis may extend to other muscles, *e.g.* those of the feet and toes, so that *ankle-drop* is produced. This form of paralysis constitutes the peroneal type. The muscles of the leg and thigh escape. The common extensors of the toes and big toe suffer so that the individual is unable to bear his weight on the outer border of his foot. When the muscles of the trunk become paralysed the patient is in a sad plight. He cannot turn in bed, he is perfectly helpless. There is a danger of the paralysis extending to the muscles of deglutition and respiration. In some cases the muscles of the eyeball are affected. In plumbism the paralysed muscles lose their response to electrical stimulation. Even under treatment, lead paralysis is slow to disappear. The knee-jerk is sometimes absent. Occasionally lead-poisoned patients have symptoms not unlike those observed in tabes. In standing or walking there may be staggering which is aggravated by closure of the eyes, also loss of the knee-jerk. In others the symptoms resemble those of general paralysis, there being loss of memory, muscular tremor of the lips and tongue, and embarrassment of speech, but instead of these symptoms as in general paralysis, becoming worse, they tend to improve under treatment.

In chronic cases of saturnine poisoning there is albumen in the urine. Consequent upon the anatomical changes induced in the kidneys and the impairment of their functional activity, structural alterations are subsequently set up in the heart and arteries, not unlike those observed in chronic interstitial nephritis. In the urine there is a deficiency of urea. The nitrogenous metabolism of the body is interfered with, so that where there is a tendency to uratosis, plumbism favours the development of gout. The association of gout and lead-poisoning is observed with much greater frequency in the South than in the North of England or Scotland, a circumstance which suggests that other factors than plumbism are concerned, such, for example, as the habits of the people and the nature of the alcoholic drinks consumed. In women plumbism often induces menorrhagia, and if pregnant, causes them to miscarry. Female lead workers, when pregnant, if they wish to go to term and have a living child, should therefore retire from the factory for a period. Not only does lead induce abortion in the mother, but it causes convulsions in her children. Most of the children of lead-workers die either at birth or shortly afterwards from convulsions.

There is a form of acute lead-poisoning which is rapidly fatal. If it is not immediately fatal it is almost sure to be followed by sequelæ of an unusually anxious character. It is known as *saturnine encephalopathy*. A lead-worker, who, perhaps, has previously suffered from colic and mild wrist-drop, or who, perchance, has never exhibited any of these symptoms, except complained of severe headache, is suddenly seized with convulsions and unconsciousness. At the time of the seizure he may be in the factory. He is taken to a hospital where it is found that the convulsions keep recurring, and although consciousness is not completely restored, he moans as if in pain, and is restless. In the urine, which is drawn off by catheter, there may be albumen, or if the patient is young and has only worked a few months in the lead factory, the urine may be found to be quite healthy but scanty. The pulse is small, and of fairly high tension. In one of the epileptiform seizures the patient perhaps dies, usually about the third day; or it may be that he recovers, and as consciousness is regained, the patient complains that he cannot see. This loss of vision may be temporary or permanent. On examining the fundus oculi ophthalmoscopically, well-marked signs of neuro-retinitis are observed, also retinal hæmorrhages; and as these occur in patients whose urine is often free from albumen, they are probably the result of the action of lead itself upon nerve-tissue, rather than, as some physicians maintain, uræmic in origin. In the milder forms of lead-poisoning there may be temporary amblyopia, without any marked changes in the disc and retina, a condition probably due to a toxic effect produced by the lead upon the cerebral visual centres. Premonitory to an attack of lead encephalopathy in females, it is no uncommon thing for them to exhibit what appears to be ordinary hysterical symptoms. This form of *toxic hysteria* is extremely fatal, and is apt to throw even careful observers off their guard. Out of the hysterical symptoms convulsions develop, and within three days the patient may be dead. Delirium of a very acute character, accompanied by high temperature, often follows an apparent recovery from lead encephalopathy, but it wears out the strength of the patient, and he dies within a few weeks afterwards; or after the acute delirium subsides there remain delusions which oblige the patient to be removed to an asylum. Females are more predisposed to lead encephalopathy than males.

Pathology.—In acute lead encephalopathy there may be practically no definite morbid anatomy. The surface of the brain may look dry and the convolutions feel hard and firm; the blood-vessels may be injected, and on slicing the brain the tissue may be extremely pale or watery, as in uræmia. On microscopical examination of the liver there may be signs of commencing intercellular cirrhosis. The kidneys in acute lead-poisoning in young subjects exhibit signs of commencing parenchymatous nephritis; in chronic cases there is well-marked interstitial nephritis. In chronic lead-poisoning with paralysis the muscles are pale and wasted; the nerves exhibit a thickening of their sheath and an increase of their inter-fibrillar connective tissue; the axis-cylinder is attenuated, it is interrupted here and there in its course, a condition which Gombault described as "periaxial" or "segmentary neuritis," in which healthy and diseased portions of nerve-fibre alternate with each other. The spinal cord is for the most part healthy. Occasionally distinct changes have been observed in the anterior horns of grey matter which lead to shrinkage of the large multi-polar cells situated there, a circumstance to which many pathologists attribute the progressive atrophy of the affected muscles.

Diagnosis.—If to the fact of acute pain in the abdomen there be added anæmia, history of the patient having been exposed to lead, also the presence of a blue line on the gums, the diagnosis of lead colic is pretty certain. Appendicitis as a possibility should not be forgotten. The bilateral character of the wrist-drop suggests poisoning of some kind, and the fact that the paralysis affects the wrist and not the legs is in favour of lead as opposed to arsenic and alcohol as the cause. Saturnine encephalopathy might be mistaken for uræmia, especially when there is albuminuria. The presence of a blue line on the gums would be an aid in the diagnosis, and in any doubtful case the urine should be tested for lead.

Prognosis.—Lead colic is, practically speaking, always recovered from: less than 1 per cent die. Recovery from saturnine paralysis is slow and often incomplete; yet I have seen complete recovery even in the worst cases when the muscles of the arms, legs, trunk have all been involved. The most serious type of lead-poisoning is that known as saturnine encephalopathy. In the chronic form of plumbism, where the kidneys are affected, the tendency is for the symptoms to get worse, and for the patient to die from cerebral hæmorrhage and convulsions.

Treatment—Preventive.—Where plumbism is due to drinking contaminated water the recommendations made at the commencement of this paper should be followed. It cannot be too much insisted upon that lead-poisoning is much more likely to be caused by the continual entrance into the system of very minute quantities of lead than by one or two large doses. For industrial lead-poisoning the Home Office has drawn out a series of regulations, the main points in which are personal cleanliness, washing of the hands and also of the face before eating, for lead dust collects upon the beard and moustache, the wearing of respirators, and periodical medical examination of the workers. Acidulated drinks are provided in many of the factories, but too much reliance must not be placed upon these. They contain Epsom salts and fresh lemon juice. Theoretically it is supposed that they convert the chloride of lead in the alimentary canal into the sulphate, but while this is a less soluble compound than the chloride it is not so insoluble as to be free from risk.

Therapeutic.—For lead colic warmth to the abdomen; the administration, in the absence of severe sickness of a mild purgative, *e.g.* Epsom salts or castor oil; a warm bath may be given. If pain is not quickly relieved, a hypodermic injection of morphia may be necessary. When colic is more continuous and diffused over the abdomen I have found monosulphite of soda in ten-grain doses thrice daily quickly relieve the pain. Olive-oil in tablespoonful doses relieves pain if it can be borne. If the bowels are not relieved enemata must be administered. When there is repeated vomiting an effervescing bromide and belladonna mixture is worthy of a trial. Of the drugs given with the object of eliminating lead from the system, iodide of potassium is the most reliable. It must in the more acute forms of plumbism be given with caution, for experience confirms the statement made many years ago by Melsens that potassium iodide is capable of dissolving out lead which has been deposited in the tissues, and of inducing symptoms of fresh poisoning. For lead paralysis massage, electricity applied either directly to the limbs or by means of alternating currents in an electric bath, also the administration of potassium iodide and nux vomica, or the hypodermic injection of liquor strychniæ may be tried. Where there is marked anæmia and loss of strength syrup of the iodide of iron and bone marrow tabloids are often beneficial. For saturnine encephalopathy pilocarpine administered hypodermically, or a disc placed upon the tongue of the patient, also nitrite of amyl inhalations, or saline transfusion, are well worthy of a trial.

MERCURY

Until within recent years mirrors were *silvered* by means of quicksilver. The use of this metal was the cause of a considerable amount of poisoning in those who followed the trade. Since the introduction of the new method by means of silver nitrate and tartaric acid mirror-makers no longer incur the risks of former days. In the manufacture of scientific instruments of precision, such as barometers, thermometers, etc., quicksilver is still largely employed. Men who follow this avocation occasionally get poisoned, so too do felt-hat makers. It is found that the *felt* out of which hats are made can be more readily manipulated, and that it lies better if it has been passed through a solution of nitrate of mercury. The danger from using this salt is less when the felt is wet than after it has become dry, for the particles of the mercuric salt are in this form inhaled. Should a workman get a cut on his finger when manipulating the wet goods the wound is apt to become very painful and irritable. The introduction of American machinery, *e.g.* the Blake machine, into the manufacture of boots and shoes has, owing to the presence of a trough filled with quicksilver in the upper part of the machine in order to allow a revolving arm to move easily upon a joint, been followed by signs of mercurial poisoning. Mercury volatilises at a very low temperature, so that in the over-heated and close rooms of a boot factory lit up on a winter's night by numerous jets of gas, of which there is always one on each machine, there is abundance of opportunity for the escape into the workroom of the metallic vapour. Until the California mines were opened most of the mercury used in our own country came from Almaden in Spain. The mining of quicksilver is a most unhealthy occupation, but newer methods of getting the metal and an improved system of ventilation have materially improved the lot of quicksilver miners. Formerly the conditions in the Spanish mines were so bad that the work had to be undertaken by gangs of convicts, but so unhealthy was the occupation and so wanting in personal cleanliness were the men, that quicksilver-mining, although slower in its operation, became just as certain a means of shortening life as the execution of a death sentence by a quicker method. The Californian miners have not suffered like the Spanish. There is in some people a peculiar idiosyncrasy to mercury and its compounds. I have a medical friend who is severely purged with one grain of calomel, and a short time ago one dose of two grains of calomel administered by me to rather a pale girl was followed by intense salivation, swollen and painful gums, and fetid breath for several days. Mercury is readily absorbed through the skin, hence this forms a useful channel for introducing, by means of inunction, the oleates of the metal.

Symptomatology.—The symptoms of mercurial poisoning may be acute, subacute, or chronic. Individual susceptibility to mercury has to be remembered. The most common symptoms are a disagreeable taste in the mouth, fetid breath, nausea, and vomiting, excessive flow of saliva, and ulceration of the gums with pallor of the face. Persons suffering from anæmia and Bright's disease are readily influenced by mercury. Workers in trades in which quicksilver or compounds of mercury are used do not suffer severely from the mouth conditions just mentioned, but they are not altogether exempted, for they are found to be cachectic, and to possess also a fetid breath, their teeth are loose and the margins of the gums ulcerated. In addition they are the subjects of muscular tremor, which, usually commencing in the tongue and lips, extends to the muscles of the limbs and trunk. At first this tremor is only induced by exertion, but after a time it is more or less constant, although it usually ceases when the individual is asleep. The implication of the tongue and lips causes impairment of speech. Occasionally there is paralysis, but the loss of power is never so pronounced as in lead-poisoning, neither do the muscles waste so rapidly nor lose their electrical reaction. The knee-jerks may not be altered. The nutrition of the body is, generally speaking, deranged. It is an interesting fact that while by means of very small doses of mercury the metabolism of the body is quickened so that a patient when undergoing treatment by means of the drug may put on flesh, large doses have just the opposite effect, for owing to the continued entrance of the metal into the system there occur progressive emaciation, an earthy pallor or pigmentation of the skin, falling out of the hair, brittleness of the nails, rheumatic pains, albuminuria, and tremor.

In acute cases of mercurial poisoning, such as that caused by taking corrosive sublimate, there are extreme pain at the stomach, severe retching, vomiting, sense of great constriction in the gullet, profuse diarrhœa, a feeling of intense distress, a sense of great exhaustion, œdema of the glottis, and death from asphyxia or convulsions. The profuse diarrhœic discharges involuntarily expelled by a patient in the throes of corrosive sublimate poisoning render attention to the patient by a medical practitioner and friends a very unpleasant undertaking. Acute mercurial poisoning by the bichloride of mercury is generally suicidal. On an average in this country five deaths per year can be traced to corrosive sublimate. The bichloride of mercury is a powerful poison. Three grains have caused death.

Pathology.—When death has been caused by corrosive sublimate there is observed pallor of mouth, throat, and gullet, and on examining the interior of the body the mucous membrane of the alimentary tract is found ecchymosed in nearly its whole length. In cases of chronic poisoning mercury seems to have the power of dissolving lime salts out of the bones, and these are deposited in the tubules of the kidney in the form of small chalky masses. When there has been paralysis the nerves are found to have undergone degeneration, fatty changes being very noticeable in the myelin sheath.

Diagnosis.—If the case is one of acute mercurial poisoning the extreme pain at the epigastrium, severe vomiting and profuse diarrhœa with collapse, and the history of some drug taken suggest poisoning by corrosive sublimate. In chronic cases the earthy pallor of the skin or bronzing, the muscular tremor and paresis, with slight embarrassment and slowness of speech, recall disseminated sclerosis, but there are not the nystagmus and exaggerated knee jerks which are present in that illness. The rather loose teeth with ulcerated gums and absence of blue line and colic show that it is not a case of plumbism. In some cases the symptoms are suggestive of general paralysis, but there are none of the grandiose ideas nor the pupillary and mental changes met with in that illness.

Prognosis.—If a large dose of corrosive sublimate in solution has been taken the patient will probably die. It is a strong irritant poison. Soothing substances therefore must be given. Milk with white of egg answers very well, for the mercury enters into combination with the latter, forming a rather insoluble albuminate. If possible the stomach should be washed out, but as the mucous membrane of the mouth and gullet has been rendered white and tender by the poison, care must be taken in passing the tube down the œsophagus. Vomiting is usually present; this should be encouraged by tepid drinks of sulphate of zinc and by a hypodermic injection of four minims of apomorphia. In industrial mercurial poisoning there ought to be better ventilation of the workrooms and the removal of dust by a Blackman's fan; personal cleanliness of the workers should be insisted upon; the men ought to be provided with astringent and antiseptic mouth washes, be given at least a pint of milk daily, and have sulphur baths. In cases of paralysis recourse must be had to massage and electricity. To patients in whom decalcification of bone is taking place the internal administration of calcium phosphate is called for.

Phosphorus and Lucifer Match-Making

Poisoning by phosphorus occurs under two different circumstances: (1) suicidal or accidental, in which the symptoms are of an acute character;

(2) industrial poisoning in lucifer matchmakers, in whom the symptoms are subacute or chronic. It is said that acute phosphorus poisoning never occurs in lucifer matchmakers. Practically this is the case, for only one or two instances have been reported. Phosphorus is *allotropic, i.e.*, is capable of existing under two different forms and of presenting different physical characters, yet retaining the same chemical composition. There are, consequently, two kinds of phosphorus, red and white or yellow. Red phosphorus is obtained from white by exposing the latter to a very high temperature in air-tight iron vessels. By this means its phosphorescence is lost and the metalloid ceases to catch fire on percussion or friction. White phosphorus is obtained from bone. It alone is dangerous. A very few grains of it will cause death. Persons who resort to phosphorus as a means of committing suicide usually take it in the form of rat or vermin paste, or they dissolve a number of match heads in water. The composition with which matches are headed contains 5 per cent of white phosphorus, occasionally more. Phosphorus is also taken by ignorant and determined females with the view of producing abortion. In Sweden, a few years ago, the number of deaths from phosphorus taken for this purpose had become so large that Parliament was obliged to consider the advisability of interdicting the use of white phosphorus altogether, and had it not been for the commercial aspect of the question the Bill would assuredly have passed. If women only knew the amount of actual pain and general suffering that phosphorus causes during the few days of life that remain to them after swallowing the poison, they would not so light-heartedly resort to it as a means of self-destruction or for the purposes of producing miscarriage. Two grains of phosphorus have proved fatal. Match heads contain phosphorus varying from ·058 to ·116 grains, so that a solution of from 20 to 100 match heads might if drunk cause death. Suicides generally empty 1 or 2 boxfuls. Red phosphorus is not very poisonous. It can be administered to animals without serious consequences following. Risks to health in lucifer matchmakers are only incurred by those who have to do with white phosphorus. Matches made from red phosphorus strike only upon the prepared surface on the box. They are known as *safety* matches, and they are safe not only as regards accidental firing from percussion but poisoning as well. It is different with white phosphorus. Male and female lucifer matchmakers alike suffer. Phosphorus affects the workpeople probably by the fume given off during the mixing of the composition if done in an open vessel, during the dipping of the matches on an open iron slab, and during the drying and boxing of the matches. My experience of animals exposed to the fumes of phosphorus leads me to believe that the fume given off by the heads of matches is as destructive if not more so than that from pure phosphorus. In match works the men who dip or head the matches are exposed to the fumes of the fresh phosphorus composition, and they suffer in consequence. So too do the women who handle the matches and fill the boxes. Their hands smell strongly of phosphorus towards the end of a day's work, and from the water in which they wash a certain amount of phosphorus can be recovered. In the act of filling the boxes some of the matches often take fire, and the thick clouds of smoke that rise render the atmosphere of the boxing-room thick and impure, also irritating to the respiratory passages when inhaled, but the phosphorus that poisons the workpeople enters the system not by this means, but in the form of the more direct fumes from the metalloid itself.

Symptomatology.—When a person has swallowed vermin paste or drunk water in which match heads have been soaked for a sufficient length of time he will, within two or three hours, sooner if the stomach has been empty, complain of acute pain at the epigastrium, followed by retching and vomiting. The vomit smells strongly of phosphorus and may contain blood and biliary colouring matter. The retching and vomiting may continue for a few days, and there may be diarrhœa. If the case has not been treated early enough, that is, before absorption has taken place, jaundice comes on about the third day, and with the onset of jaundice the liver is usually found to be somewhat enlarged and tender. The pulse is small and rapid. The patient feels depressed and ill. Temperature may be unaffected. A high temperature is regarded by many as an unfavourable sign. The urine may or may not contain albumin, as a rule not. Crystals of leucin and tyrosin can be found in the urine if it is carefully manipulated and prepared for their detection. When the jaundice is not marked and the patient has been treated early, improvement may set in within a few days, but a deepening jaundice and the advent of coma point to a secondary poisoning of the patient through imperfect elimination caused by structural changes in the liver, kidneys, and blood-vessels. In severe cases death comes towards the end of the first week, but in children phosphorus poisoning has proved fatal in a few hours. In addition to vomiting and abdominal pain there may be delirium and convulsions. The skin is often the seat of numerous small petechial-like hæmorrhages. Sometimes the red blood cells are increased in number, on other occasions they are diminished. Women, if pregnant, usually miscarry. The fœtus is dead. In severe cases of poisoning, completion of the labour is followed by increase of the jaundice, greater tenderness over the liver, diminution in the size of the organ, coma, and death.

The symptoms of industrial phosphorus poisoning are more of a local than a general character. Acute poisoning, practically speaking, never occurs in lucifer matchmakers. The principal accident that happens to them is necrosis of the jaw-bone. At its commencement this is a very painful affection, and it is not always relieved by extraction of the decayed tooth. It is a periostitis followed by inflammation of the bone and then by necrosis. For many months pus keeps oozing into the mouth from the affected socket, and as some of this during sleep may trickle down the pharynx or be swallowed with the food, the patient runs the risk of infection, especially as the pus contains numerous micro-organisms. Among these Professor Stockman detected a few tubercle bacilli. The glands below the jaw are sometimes enlarged and tender. In France a constitutional condition described as *phosphorism* has been observed in lucifer matchmakers, the principal symptoms of which are a peculiar pallor, attended by slight yellow tinging of the skin and by albuminuria.

Pathology.—In acute phosphorus poisoning death may supervene in from three to five days. The cadaver is usually jaundiced. In the skin and serous membranes, also in the muscles and between them, may be seen numerous petechial hæmorrhages, the blood in which is dark. On opening the internal cavities a distinct odour of phosphorus may be detected. Lungs may present nothing abnormal. The pericardium is often the seat of numerous small hæmorrhages, so too is the surface of the heart and the myocardium. The diaphragm, too, may be the seat of small hæmorrhages. The liver is greenish in colour, enlarged in the early stages, and so fatty that the greasy material adheres to the knife when the organ is cut. The spleen is usually not enlarged. Kidneys are pale.

On microscopical examination the myocardium and the muscles of the body generally are found to have undergone fatty degeneration, consequent upon imperfect oxidation of cellular protoplasm during life. The numerous ecchymoses are the result of fatty degeneration of the walls of the small blood-vessels. The liver cells are observed to be extremely fatty, and the biliary canals are the seat of catarrh, due to the unhealthy bile having induced a subacute inflammatory condition of their lining membrane. It is to this circumstance that the jaundice is attributed. The kidneys, too, are the seat of well-marked fatty degeneration. By means of osmic acid the fat can be demonstrated in the form of black granules. It is largely owing to the destructive changes induced in the cells of the liver and kidney that there occurs retention of animal products within the body, which is the cause of the coma that is invariably fatal. On examining the stomach in very recent cases the mucous membrane is found to be red, and the seat of hæmorrhages. The brain and nervous system exhibit nothing very abnormal.

In lucifer matchmakers phosphorus poisoning takes the form of necrosis of the jaw-bone, more frequently of the lower than the upper. It has not yet been definitely settled as to how exposure to phosphorus causes death of the bone. Formerly it was considered to be the sole result of the action of phosphorus fume, *i.e.*, a mixture of phosphorus and phosphoric oxide, operating through a decayed tooth upon the socket and setting up periostitis. It is generally admitted that workpeople with decayed teeth are more susceptible than others. Professor Stockman of Glasgow found tubercle bacilli in the pus that escaped from a necrosing jaw of a matchmaker, and he therefore considers the process to be tubercular; but as there are many kinds of micro-organisms in the mouth, and also in decayed teeth, it is difficult to say whether the necrosis is entirely tubercular. Exposure of dogs and monkeys to the fumes of phosphorus, with, in addition, inoculation of the gum by a culture of tubercle bacilli, is not followed by necrosis of the jawbone. There is something peculiarly human underlying this question of phosphorus necrosis in lucifer matchmakers. Once the disease is established and the decayed tooth removed the affected bone, if not treated surgically, may keep discharging pus for several months, when a sequestrum comes away, and the bone heals, leaving often very little deformity. Where the necrosis affects the upper jaw bone there is a tendency for meningitis to be induced, which becomes purulent, and is rapidly fatal. In some of the patients tubercular lung disease is established, and in others there is albuminuria, which may be due to amyloid degeneration of the kidneys.

At Grammont in Belgium, which is one of the principal seats of the manufacture of matches in that country, I had the opportunity of discussing the question of necrosis with Dr. Brocorens, who has had a large experience of the maladies of lucifer matchmakers. During twenty-five years he has met with 30 cases of spontaneous fracture of the long bones of the limbs in matchmakers who had previously suffered from necrosis of the jaw due to their occupation. This accident suggests that in addition to the local effects produced upon the maxillæ, phosphorus is capable of setting up pathological changes in other bones, whereby they break without any strain at all. Fracture of the femur in matchmakers in England is not unknown. Dr. Dearden of Manchester reported the case of two dippers, each of whom had at different times both thigh bones broken in the simplest manner possible.

Diagnosis.—Acute and subacute phosphorus poisoning resembles acute yellow atrophy of the liver, but in the latter there is usually deeper coma, and the liver diminishes rapidly in size, whereas in phosphorus poisoning the onset of jaundice is attended by enlargement of that organ. The spleen, if enlarged at all, is usually more so in acute yellow atrophy of the liver than in phosphorus poisoning. Occasionally even at the autopsy it is difficult to differentiate between the two. Acute yellow atrophy is prone to develop during pregnancy, and it is when women are pregnant that they often, as we have seen, resort to phosphorus to cause miscarriage. Dr. Vivian Poore maintains that clinically acute yellow atrophy of the liver and phosphorus poisoning are indistinguishable. Hypertrophic cirrhosis of the liver has been mistaken for phosphorus poisoning, but the symptoms are usually not so acute. Uræmia with jaundice might under certain circumstances also resemble it, but an examination of the urine for albumen would to some extent help to settle the diagnosis.

The *Prognosis* is grave if a large quantity of phosphorus has been taken. Fully one-third of the patients die, many of them within three days of taking the poison. Those patients who survive this period may die from syncope, due to fatty heart.

Treatment.—The main object is to prevent absorption of the poison from the stomach, and thereby the pathological changes in the liver and kidneys upon which the secondary poisoning and coma depend. Emetics and purgatives should be administered early, but it is preferable to wash out the stomach with plenty of lukewarm water until all odour of phosphorus has disappeared, adding to the water towards the end of the lavage copper sulphate (1 in 100), since this forms, with any phosphorus that has been left in the stomach, an insoluble phosphide of copper. Permanganate of potassium may be substituted for the copper salt. The administration of spirits or oil of turpentine will be found to be as near an antidote to phosphorus as possible. All fatty food, *e.g.* milk and oily substances, must be avoided, for these dissolve phosphorus, and therefore favour its absorption. The essential oils, such as turpentine and cloves, also such a liquid like ether, check the glow or phosphorescence of phosphorus, that is to say its oxidation; it is when in this transitional state that phosphorus is harmful. Saline aperients should be administered. Castor oil, for the reasons just stated, must be avoided. The possibility of syncope coming on should be anticipated by the administration of heart tonics and stimulants, *e.g.* digitalis and ammonia. Treatment of the necrosed jaw-bone may be expectant. By means of antiseptic mouth-washes the effects of the diseased bone may be materially held in check. A sequestrum of varying size may come away after a few months, or the piece of the jaw-bone may be removed by the surgeon. Both lines of treatment give practically the same results. Most of the patients recover.

To check industrial phosphorus poisoning regulations have been framed by the Home Office. Of these, personal cleanliness of the workpeople, the introduction of fans for improving the ventilation of dipping and drying rooms, also of the tables where the boxing is carried on by hand, and periodic dental inspection of the workers are the principal points. Efforts are now being made to manufacture strike-anywhere matches without yellow phosphorus at all. In France they have succeeded in making matches from sesquisulphide of phosphorus. These have most of the advantages of the strike-anywhere matches, without being poisonous. The demand by the public for safety matches should be encouraged.

BISULPHIDE OF CARBON POISONING AND INDIA-RUBBER MANUFACTURE

The india-rubber trade gives employment to a large number of men, women, and young persons. The increasing uses to which electricity is being put has given a stimulus to this industry. India-rubber is used for insulating electrical wires, also in the manufacture of waterproof garments, toys for children, tobacco-pouches, etc. In the factories where these articles are made, large quantities of naphtha are used to dissolve the rubber. The pungent vapour of the naphtha is at first very irritating to the eyes and the respiratory passages, but the workers soon get accustomed to this. What the workpeople complain of is that the taste of the naphtha lingers in the mouth long after they have left the factory, so that it prevents them taking food with any relish. Partly owing to this circumstance, and to the fact that the work is carried on often in over-heated and ill-ventilated rooms, the girls become anæmic, and suffer much from headache. Beyond these facts and the discomfort which naphtha vapour sometimes causes, it cannot be said that any serious illness has been traced to its employment. It is otherwise with those processes in the manufacture of india-rubber goods in which *bisulphide of carbon* is used. India-rubber has to be vulcanised, in order to render it capable of withstanding alternations of heat and cold. Vulcanisation of rubber goods is generally done by means of sulphur burned in close chambers or by using bisulphide of carbon. It is with the latter we are chiefly concerned. Bisulphide of carbon confers pliancy and elasticity upon india-rubber, and prevents it from becoming hard. The finer goods, such as children's balloons and tobacco-pouches, are dipped in bisulphide of carbon, a liquid that gives off a most offensive and repellent odour; it is also very volatile and its vapour is inflammable. All manufacturers are agreed that it is an excellent compound for the purpose to which it is put. Several substitutes have been tried, but as yet none has replaced it. For the vulcanisation of india-rubber 2 to 10 parts of chloride of sulphur are generally added to 1000 of bisulphide of carbon. As it is a very inflammable substance, the processes in which it is used are carried on in the top story of the factory, and in rooms without a fireplace or naked lights.

Symptomatology.—Inhalation of the vapour of bisulphide of carbon has a peculiar intoxicating effect upon some of the workpeople. Prolonged exposure to the vapour causes peripheral neuritis. Men and women lose the power in their arms and legs, and once paralysis is developed it is slow to disappear. Before the paralysis occurs there is often observed a staggering gait. Inhalation of the bisulphide vapour causes the workpeople to be drowsy. They sleep heavily over night, and waken often with a splitting headache in the morning. The girls and young women who dip balloons and tobacco-pouches in the bisulphide suffer from headache and vomiting accompanied by dizziness, and they complain of tasting the nauseous compound in their food. On going home from the factory at night they sometimes stagger and reel as if intoxicated. They even fall. After reaching home they are so tired that they often go to sleep before touching their evening meal. This sleep is heavy and unrefreshing. Next morning they proceed to their work languid and feeling nervous and shaky. They do not feel comfortable until they have again inhaled some of the vapour of the bisulphide. Upon some of the workers the carbon compound exercises a more injurious influence than that just described. It causes acute mania. Often the outburst is as sudden as it is unexpected, and in their frenzy affected workpeople have been known to throw themselves from the top story of a factory. Bisulphide of carbon also causes temporary loss of vision; in some instances it acts as an ecbolic, while upon young women it occasionally induces symptoms of a peculiar hysterical nature—a mixture of hysteria and intoxication. This toxic hysteria, like that which occurs in plumbism, is often the prelude to a deeper and more serious form of poisoning, and should on no account be underestimated.

Diagnosis.—In acute cases the history of the occupation of the patient and the presence of a disagreeable odour that may possibly be about his clothes would suggest bisulphide of carbon poisoning. The bilateral character of the paralysis would also suggest poisoning, but not its cause. Absence of blue line on the gums would show that it was probably not due to lead. The affected limbs are not so tender to the grasp as in arsenical poisoning. Speaking generally, apart from the history of the case, it would be difficult to say what is the cause of the paralysis.

Treatment.—(1) *Preventive.* Removal of the patient from work. Free ventilation of the workroom and withdrawal of the vapours away from the face of the workers by means of fans. Alternation of employment in the factory. (2) *Medicinal.* In the acute forms of poisoning bromide of potassium with sulphate of magnesia; for paralysis massage should be tried and the application of electricity; internally nux vomica or liq. strychniæ supported by a liberal diet.

INFLAMMABLE PAINTS AND BENZINE

Inflammable Paints.—The use of composite or spirit paints has been frequently followed by symptoms of poisoning in men engaged in painting ship's holds or confined spaces in ships. These composite paints dry very quickly, and in consequence they are much in demand for ships, to the owners of which time is money. The drawbacks to these spirit paints are mainly two: (*a*) they are so very inflammable that a man cannot or ought not to be allowed to work with them in a confined space with a naked light; (*b*) since they contain large quantities of petroleum or methylated spirit combined with benzine, inhalation of the vapour causes the workmen to become intoxicated, and sometimes to be violently sick. In several instances the men, overcome by stupor, have been unable to leave the compartment, and have had to be removed by means of ropes. On bringing them up to the deck the workmen have been found to be unconscious, to be rather pale than cyanosed, and they have vomited, the vomited matter smelling strongly of the spirit paint. Some of the men, too, have had epistaxis. After being roused into consciousness not a few of them have lapsed into a deep sleep for several hours.

Treatment.—Too great care cannot be exercised so as to prevent the vapours from the paints catching fire. No naked lights should be allowed where men are using them, nor should the men be allowed to work in close and confined compartments for more than an hour or two at a time. They should come out into the open air. On taking up this particular kind of work the dangers of the occupation ought to be clearly pointed out to the men by their employers. Where the symptoms are those of acute intoxication the best treatment is to place the patient in as pure air as possible, so that he may by ventilating his lungs, rid his blood of the deleterious vapour, care being taken in cold weather to have the body well covered with rugs to avoid being chilled. Subsequently a saline aperient should be administered.

Benzine.—Soiled gloves and garments are cleaned by means of benzine in "dry cleaning" establishments. Occasionally naphtha is used for the same purpose. Benzine is a very inflammable and highly explosive compound. Fires break out during the summer months in dry cleaning establishments in the most unaccountable manner. They have been attributed to friction, and to electric sparks, while in a few instances they have doubtless been due to accidental ignition of lucifer matches concealed in the clothing sent to be cleaned. As a rule, all the pockets of the clothes are turned inside out and all metallic buttons are removed before the clothing is placed in the revolving cylinders that contain the benzine. Two risks are run by the workpeople: (1) danger from fire and explosion; (2) effects due to inhalation of the benzine. Too great caution cannot be exercised in regard to the manipulation of benzine. There should be no naked lights about at the time it is being handled. Benzine, when inhaled, often causes young female workers to become extremely hysterical, loquacious, and excited. Frequently, too, it causes headache and giddiness. If the work has been conducted in rather a close room, the men and women become mildly intoxicated. Benzine vapour produces a heavy sleepy feeling, which obliges the workpeople to go out into the fresh air.

Treatment.—Preventive by having the workroom well ventilated. In the case of fire the best way to extinguish the flames is by means of sand. Blankets ought also to be in readiness to throw around any worker whose clothing may have caught fire. When there are symptoms of intoxication the workpeople should be taken into the fresh air. This is generally sufficient to restore them.

Aniline and Dinitrobenzine

The discovery of the coal-tar products has revolutionized chemistry as applied to the arts and manufactures. Many of these bodies, *e.g.* the picric acid compounds, are used in the manufacture of the higher explosives, while others are used for dyeing purposes. Dearden has described the symptoms observed in workmen employed in the dyeing of fast aniline blacks. Dyeing by means of aniline black agents is indirectly brought about through the medium of an aniline salt or aniline oil. The salt employed is obtained by acting upon aniline with hydrochloric acid in *closed* vessels. When not obtained in this manner a considerable amount of fume is given off, inhalation of which causes great prostration, dyspnœa, intermittency with rapid action of the heart, lividity of the face, blueness of the lips and finger nails. Symptoms of a similar character have been observed by Prosser White in men employed in the manufacture of nitro-benzole. Since nitro-benzole is a frequent impurity in aniline oil some of the symptoms just detailed may probably be due to this substance. In dye-works the cloths that have been dipped in aniline liquor must be dried and mangled, and subsequently the dye is oxidated and chromed. In the ageing or chroming room large quantities of sodium bichromate are used, and workmen who carelessly allow the edge of the cloth to run through their fingers often suffer from chrome ulcers on the hands.

There is an idiosyncrasy to aniline poisoning. Some persons are more susceptible to it than others. The symptoms of acute aniline poisoning are nausea with prostration amounting at times to collapse; the features become livid and the extremities cold and blue; there is dyspnœa accompanied by a feeling of drowsiness; the pulse becomes small, rapid, and intermittent, the pupils are dilated and the urine dark coloured. Many of these symptoms can be prevented by better ventilation of the factory, but even in those that are best ventilated it is not uncommon for the workmen to complain of nausea and extreme lassitude, for the face to be livid, and the lips and nails cyanosed.

Poisoning may be prevented by having the rooms in dye-works lofty, cool, and well ventilated. Handling of the chromed goods should only be done by men wearing india-rubber gloves. Personal cleanliness is a necessity. The hands should be well washed before meals and no food eaten in the work-rooms. Alternation of employment is desirable. The men should not work long in any of the dangerous processes.

In France several cases of fatal poisoning have occurred, especially in young people, in consequence of a particular kind of paste being used to blacken fawn-coloured boots. The symptoms were the same as those above mentioned. On analysis the paste was found to contain as its principal ingredient aniline oil.

What has been said of aniline will almost equally apply to the nitro- and dinitrobenzine compounds that are used in the manufacture of the higher explosives, roburite, etc. This subject has received literary attention at the hands of Drs. E. S. Reynolds and Prosser White. It has also been treated by Simeon Snell, who found failure of eyesight a common symptom due to concentric contraction of the visual field with central colour scotoma and occasionally blurring of the edges of the disc, appearances that as a rule subside on the men giving up their work. Dinitrobenzine is a powerful poison whether inhaled or swallowed, rubbed into the skin, or injected into the circulation. A little over one gramme when taken by the mouth will cause death in less than twenty-four hours. The concentrated vapour is particularly dangerous. Poisoning by dinitrobenzine may be acute, subacute, or chronic. Men who breathe the vapour during work often become sleepy and complain of severe headache; the heart's beat becomes irregular, and the men experience a difficulty of breathing; their face is observed to be cyanosed, and the urine they pass exhibits a reddish brown colour free from albumin and sugar, but which on spectroscopic examination gives the spectrum of methæmoglobin with some other pigment not yet definitely named. In acute poisoning death is preceded by coma. At the autopsy the brain is found to be congested, the blood dark and thick, the chambers of the heart are dilated, and the lungs either dark or very pale. There is often exhaled from the body a strong odour not unlike that of bitter almonds. A similar odour is detected in prussic acid poisoning, but the symptoms caused by prussic acid are more sudden in their development than those of dinitrobenzine poisoning.

In the chronic cases the skin becomes dirty yellow; the men complain of feeling languid and of being sleepy, and their gait is often ataxic. Occasionally the skin is at places anæsthetic or hyperæsthetic, and the urine is of a deep maroon colour. When dinitrobenzine kills it is generally by inducing coma. The blood corpuscles disintegrate under its influence, and, as a consequence, oxygen fails to be taken into the system. Although chemical changes occur in the passage of these nitro compounds through the body, it is difficult to say what is the exact nature of these changes.

In order to prevent dinitrobenzine poisoning the workrooms should be airy and well ventilated. The workmen should wear respirators; when handling the material gloves ought to be worn. Personal cleanliness is also most important, and there should be the minimum hours of labour in such dangerous processes as grinding and the cleaning out of flues. Six hours a day spent in the rooms where the mixing is done and the cartridges are filled, are enough for any person. Since alcohol is known to increase the susceptibility to poisoning, stimulants ought to be avoided by men following this employment. There is no known antidote to dinitrobenzine; but in the acute form of poisoning, inhalation of oxygen, the application of warmth to the surface of the body, careful administration of stimulants, and rest in the recumbent position until immediate danger from syncope has passed away, will be found very helpful.

Risks attending the Manufacture and Use of Explosives

Unless the strictest precautions are observed there is no manufacture more dangerous to life than the manufacture of the so-called high explosives, *e.g.*, nitroglycerine and gun-cotton, dynamite, roburite, lyddite, etc. Major Cooper Key, H.M. Inspector of Explosives, states that in ten years there were 44 workmen killed in explosives' factories in Britain and 204 injured. No doubt many of the accidents were caused through carelessness, *e.g.*, thawing of dynamite over the fire, scraping out of detonators with pins, etc., while in quarries and mines many of the accidents have been caused by driving dynamite into roughly drilled holes, boring out missfires, etc. In the actual manufacture of explosives the workmen run little risk to health. The risk is rather one of sudden mutilation from the severity of an explosion.

Miners often complain of the effects of the fumes after an explosive cartridge has been fired in the pit. They suffer from severe headache, collapse, a sense of nervousness, muscular tremor, alternate flushing and paling of the face, followed by vomiting which often brings relief. When coal miners are the subjects of chronic pulmonary or bronchial affections their breathing for the time is rendered difficult, and the men are so prostrated that they almost collapse. Since all explosives contain carbon, these when fired either in a sufficiency or in an excess of oxygen form carbonic anhydride (CO_2), a poisonous gas, but when the oxygen is deficient carbon monoxide (CO) is formed, which is still more poisonous. While gunpowder may give off on combustion 3·6 per cent of carbon monoxide, gun-cotton will evolve as much as 28 to 45 per cent of this gas. Haldane has written upon the effects of carbon monoxide upon coal miners. In his experiments upon animals he found that an atmosphere containing 0·4 per cent of carbon monoxide caused death, and that anything above 0·2 per cent was dangerous. As the gas is, practically speaking, odourless, its presence is not easily recognised. When inhaled it causes dizziness and dyspnœa, attended by palpitation and a sense of drowsiness, or there is experienced a feeling of excitement resembling that caused by alcoholic intoxication. These symptoms are followed by loss of muscular power, mental confusion, and by unconsciousness. Carbon monoxide prevents the absorption of oxygen by the blood owing to the gas itself having entered into stable combinations with the hæmoglobin of the red corpuscles, proof of which is found on examining the blood spectroscopically. The blood is of a bright red colour, shows two bands in the yellow and green of the spectrum, and is not reduced by ammonium sulphide.

All the explosives, with the exception of nitro-glycerine and some of the ammonium nitrate products, evolve, when exploded, carbon monoxide. Nitro-glycerine, on the other hand, gives off carbonic anhydride, sometimes to the extent of 58 per cent. There are in addition nitrous fumes, and while these of themselves are dangerous their effects are exaggerated by the presence of CO and CO_2. Gunpowder gives off on ignition carbonic anhydride and nitrogen, with a small proportion of carbon monoxide and sulphuretted hydrogen. Gun-cotton, tonite, gelignite, and carbonite evolve a fairly large percentage of carbon monoxide, and are therefore dangerous when exploded in places where the ventilation is defective. The headache complained of after the firing of the high explosives is due to dilatation of the cerebral arteries, which is one of the physiological effects of nitrites.

Workers in the Chemical Trades

Although many chemical compounds are used in the arts and manufactures, the term chemical trades is usually restricted to the production of alkali, bleach powder, sulphuric acid, etc. Owing to the fact that the production of a large number of chemical compounds is generally conducted by the wet process, and that these compounds are either crystallised out of or are precipitated from solutions, there is less danger to health in their manufacture than when they are subsequently handled or inhaled in the form of dust. Any possible danger from gas in chemical works is obviated by ventilation. In the chemical trades the principal goods manufactured are hydrochloric and sulphuric acids, sodium carbonate, caustic soda, caustic potass, and bleaching powder. These are usually all produced in the same factory. In what is known as the Le Blanc process, sulphate of soda, or salt cake, is first formed by acting upon common salt with sulphuric acid. These two compounds are heated together on the bed of a furnace, and raked from time to time until the salt decomposes. Large quantities of hydrochloric acid are given off and removed by means of a blower. As this gas is extremely irritating to the lining membrane of the respiratory passages, the workmen are obliged to wear a flannel muffler tied over their face, or they bite a piece of flannel held between their teeth and breathe through it. As a consequence either of biting the flannel or of the operation of the acid fumes themselves, the teeth rapidly decay. The workmen, too, are exposed to great changes of temperature, and readily catch cold. After removal of the salt cake from the furnace it is mixed with limestone and coal in a black ash furnace; there it is heated and decomposed. This is a process apparently unattended with risk to the health of the operative. The soda having been dissolved, can be converted as required into soda ash, soda crystals, or caustic soda. The liquor containing the caustic soda has to be concentrated by heat. By degrees the cauldron holding the liquor becomes occupied by red-hot caustic soda. This is subsequently baled out into iron drums and allowed to cool, after which it is ready for the market. Considerable danger attends this process. A few drops of water falling into the liquor cause it to spurt. Beyond burns of a serious character having occurred in this process, there is nothing in it that can be said to be absolutely unhealthy to the workmen. It is different, however, with the bleaching powder made from the hydrochloric acid given off from the salt cake furnace. Chemical manufacturers require the chlorine obtained from the hydrochloric acid, and this is got either by decomposing the acid in large stills by means of manganese mud, the gas being led away by pipes to the bleaching chamber (Weldon process), or the hydrochloric acid gas, mixed with proper proportions of air and steam, is conveyed thither direct from the salt cake furnace (Deacon process). A. P. Laurie, whose description of the various processes I have followed, tells us in a paper on "Chemical Trades," that in order to prepare bleaching powder, freshly slaked lime must be exposed to chlorine gas. The lime absorbs the gas, and retains it only very slightly, for it is constantly evolving the chlorine.

The packing of the bleach powder is one of the most disagreeable operations a man in a chemical works can do. He is obliged to enter the bleach chamber, which contains free chlorine, and to shovel the powder through holes in the floor into casks. Before he can do this the packer must wrap his face in rolls of flannel, the mouth being covered, but his nostrils free. It is necessary to keep the flannel just sufficiently damp to prevent the gas reaching the lungs. Leather goggles are put on to protect the eyes, while paper leggings are worn to protect the trousers. As the man begins to shovel the bleach into the casks the chlorine gas at once rises, and were the workman not protected in the manner described, it would be impossible for him to remain more than a few seconds in the bleach chamber. As it is, the flannel wrappings cause the breathing to be very difficult and most trying. The bleach packer when in the chamber is obliged to inhale by the mouth, through the wet flannel, and exhale by the open nostrils.

Chlorine gas is extremely irritating to the respiratory mucous membrane. When inhaled it causes an unpleasant suffocative feeling. Breathing of the gas is attended by a considerable degree of discomfort, and when pushed too far causes insensibility and death.

In the manufacture of sulphuric acid iron pyrites is burned, and the sulphur dioxide as it escapes is led away into large lead chambers, where it is brought into contact with air, steam, and nitrous fumes, the latter having been obtained by acting upon sodium nitrate with sulphuric acid. Occasionally sulphur dioxide and nitrous fumes escape, and are inhaled by the workman. These gases are irritating to the respiratory mucous membrane.

Attempts are now being made, and on the whole successfully, by chemical manufacturers to recover the sulphur from the black ash left in the vat after the preparation of soda. The ash in question is rich in sulphide of lime. Hitherto this has been looked upon simply as a waste product. Large mounds of it can be seen in the neighbourhood of alkali works. These heaps when acted upon by rain and air give off large quantities of sulphuretted hydrogen. Some of this waste is taken and mixed with water; the mixture is subsequently placed in large closed vessels, and carbonic acid passed through it. Decomposition is effected, sulphuretted hydrogen being given off and carbonate of lime precipitated. The sulphuretted hydrogen is thereafter burned, sulphur and water being formed. The gas itself is not only very unpleasant, it is extremely poisonous. On allowing a dog to breathe an atmosphere containing 0·2 per cent of sulphuretted hydrogen I have seen the animal fall down apparently dead after 1½ minutes' inhalation of the gas; its breathing was completely arrested, while the heart continued to beat for a short period after death. An animal thus apparently killed by sulphuretted hydrogen might recover if placed in purer air and caused to breathe oxygen by artificial respiration. Whenever men working in chemical factories, cesspools, or sewers are brought into contact with sulphuretted hydrogen, cylinders of oxygen should be ready in case of emergency, and when men are seen to fall down they should be at once brought out into the open air, and artificial respiration adopted. In addition it may be necessary to give them a hypodermic injection of liquor strychniæ, and to administer stimulants.

Chemical labourers, as a rule, are strong healthy men to start with. Many of them, unfortunately, become intemperate, and probably, therefore, part of their ill-health may be due to this circumstance. Their work is hard. They are paid good wages, but as they spend their earnings freely on drink, many of them feed badly. The tendency to alcoholic excess is, no doubt, largely due to the nature of their employment. Diseases of the respiratory organs are common in chemical workers, but the death-rate from phthisis is below the normal for all males. How far this circumstance is due to sulphur dioxide, hydrochloric acid, nitrous fumes and chlorine being unfavourable to the multiplication of tubercle bacilli, it is impossible to say. Some medical men hold the opinion that these gases are prejudicial to the development of the bacillus. In chemical works the number of deaths from accidents is unusually large. If we take 56 as the number of deaths for all males, chemical trades stand at 98, whereas shipwrights, who also have a high mortality from accidents, number 63.

The Manufacture and Uses of the Bichromate Compounds.—Although the manufacture of the bichromates is a special industry, still the subject may be conveniently dealt with under chemical trades. Workers in bichromate compounds are prone to suffer from erosion of the septum nasi and from ulcers of the skin. Erosion of the nasal septum occurs in those who manufacture sodium and potassium bichromate, but all who handle the salts are liable to ulceration of the skin. In making potassium bichromate, a mixture of chrome ironstone, potash, and lime is roasted together. Afterwards the fused mass is lixiviated with water, sulphuric acid being subsequently added to convert the neutral chromate into bichromate. The chrome ironstone has first to be reduced to a fine powder before it is mixed with the lime and potash. When the mixture has been roasted for three hours it is withdrawn and allowed to cool, after which it is broken up and shovelled into large vats. It is when water and the solution of potassium sulphate are added that steam is given off which carries with it particles of chromate dust. After the addition of sulphuric acid the potassium bichromate in solution is run off into lead tanks, where it crystallises. The crystals have to be subsequently broken up by the workmen, and it is this process which is a source of danger in bichromate factories. The air of the room frequently contains, according to Heise, as much as 6·3 milligrammes of sodium bichromate per cubic metre. Dr. T. M. Legge, H.M. Medical Inspector of Factories, who has given considerable attention to this subject, found the nasal septum of the workmen frequently perforated. Some of the men were more susceptible than others. On an average, perforation of the septum occurred after six to twelve months' work, but others of the men who thus suffered had only worked as many weeks. The site of the ulceration is about a quarter of an inch from the lower and anterior margin of the septum. When perforation occurs it is extremely limited at first, but after the mucous membrane has been destroyed the ulceration progresses rapidly, and extends as far up as the junction of the septum with the ethmoid and vomer. The loss of substance is preceded by symptoms of nasal catarrh and sneezing. Pain is not a prominent symptom. Even when perforation has taken place the general health remains good. There is, however, considerable inconvenience from the formation of plugs of mucus in the nares and from crusting of the discharge. The "chrome holes" or ulcers observed on the skin are sluggish and slow to heal. They are generally caused by a cut or wound of the skin becoming irritated by the bichromate. Men, therefore, who have wounds on the skin should abstain from work for a time. Personal cleanliness, too, is most important. The men when working with bichromate solutions should wear india-rubber gloves. Dust should be removed by fans.

WORKERS IN ARSENIC

Arsenic, in the form of arsenite of copper, Scheele's green, and Scheinfurt or Vienna green, has long been used as a colouring agent for wall papers, for dyeing purposes, in the manufacture of artificial flowers, and the fluid known as "sheep dip" for destroying tick on sheep. Although wall-papers containing arsenic are usually coloured green, yet red, orange, and brown papers may contain the poisonous metal. It is from the dust given off by wall-papers, and arseniuretted hydrogen produced by vegetable moulds, that people have suffered through sleeping in bed-rooms the walls of which had been lined by arsenically pigmented papers. The men who make Scheele's green often have pimples on the skin that develop into boils. Others suffer from ulcers of the skin, or complain of headache, nausea, and vomiting. Men who make sheep-dipping fluid, and who are not careful to wear india-rubber gloves, may suffer from paralysis. Arsenical neuritis affects, as a rule, the lower extremities. It is this location of the paralysis and the extreme pain complained of in handling the limb that differentiate the lesion from lead-poisoning. The arms and hands, however, may also become affected. The arsenic reduction workers in Cornwall suffer from bronchitis and pulmonary diseases in excess of men in the same locality following other occupations. The arsenic powder, too, gets under their clothing and causes eczema. In deference to public opinion, manufacturers have lately discontinued the use of arsenic as a colouring agent for wall-papers, other substitutes having been found. Workers in arsenic cannot pay too much attention to personal cleanliness.

Copper and Brass—Brass-Founder's Ague

The copper ore smelted in this country is known as copper pyrites. As this often contains arsenic, serious symptoms of poisoning have occurred in smelters, probably due to the arsenic. Birmingham is the centre of the brass trade. Brass is an alloy of copper and zinc. In the fusion of these metals, and particularly during the pouring of the same when molten, the workmen have been known to suffer from a peculiar set of symptoms to which the name of "brass-founders' ague" has been given. During the pouring of the molten brass into moulds, dense white clouds of smoke arise and fill the interior of the casting-shop. From these clouds a delicate white powder gently falls, and this, on analysis, has been found to be oxide of zinc. As far back as 1862 Dr. Headlam Greenhow read a paper at a meeting of the Royal Medico-Chirurgical Society on Brass-Founders' Ague. It is now admitted that this name is misleading. Since Greenhow's time the subject has attracted the attention of Hogben, and more recently has been dealt with by Drs. Robert M. Simon and Murray of Birmingham. Opinions are divided as to whether the so-called ague symptoms are due to the copper or the zinc in the brass. It is usually when the operatives are fresh to the work, or when the men have been absent for a time, that they suffer. The symptoms are languor, depression of spirits, and a feeling of chilliness. The individual becomes pale and he has a shivering. His teeth chatter, and his face is seen to be wet with a cold perspiration. There are headache, nausea, and muscular pains. Vomiting occurs, and this is followed by a sense of relief, after which the patient often falls into a comfortable sleep from which he awakes, feeling well, though tired and weak. Both Greenhow and Hogben described a hot and sweating stage as succeeding the one just mentioned. Simon has never met with these. He therefore thinks that the term ague should be discarded altogether. In brass-workers the teeth are often green, and the gums blackened at their edges. The white hair of the older workmen is usually coloured green. As a rule the symptoms detailed above are transitory. In addition to the so-called ague many of the men suffer from bronchitis and fibroid phthisis. Brass-casters, too, are often the subjects of nervous disorders not unlike paralysis agitans. Dyspeptic symptoms are common. There are loss of appetite and gastro-intestinal catarrh; complaint of a metallic taste in the mouth, vomiting, and either constipation or diarrhœa. The men often become nervous and hypochondriacal, or they complain of headache and obscure muscular pains. A similar train of symptoms is known to occur in copper-poisoning. Stephenson says it is impossible to say whether the symptoms in brass-workers are due to zinc or copper. Greenhow attributes them to deflagrating zinc, while Hogben blames the copper. It is difficult to say which of the two metals is the cause of the symptoms. Zinc is not toxic to any extent by itself, and copper, although usually considered poisonous, is much less so than hitherto believed. Metallic copper is not at all dangerous, and copper oxide is only so in very large doses. It is just possible that the fumes given off from the molten brass are poisonous owing to some peculiar and unexplained condition in existence at the time, and therefore due to the combination of the two metals. Simon holds that the ague-like symptoms are probably caused by this admixture, while the more chronic complaints he attributes to the copper.

Milk has been proved by experience to be the best preventive of brass-poisoning, and by many it is also regarded as an antidote. The workmen resort to it on their own account. As a rule these men do not call in medical assistance for the ague. The workrooms ought to be well-ventilated so that the fumes of the molten metal may escape. It is during heavy, foggy weather, when it is difficult to clear the air of the workshops, that symptoms among brass-workers are most prone to occur.

The Textile Trades

Cotton

In the manufacture of cotton the operatives incur no special risks other than those due to working in ill-ventilated rooms, and where machinery is running at high speed. For trade purposes it was found necessary to introduce moisture into the air of the workrooms in cotton factories, and as this has been carried on frequently in excess of manufacturing requirements, the operatives have suffered in their health. It is in the weaving sheds where this artificial humidity is especially needed. Raw cotton as seen in the bales is often dirty and dusty. It has therefore to be cleaned and combed. In the process of *carding* or combing of the raw material a considerable amount of dust is given off, while in the *spinning* rooms, owing to the outside air being excluded so as to keep the yarn clean, and in consequence, too, of the rapid rate at which the machinery is run, not only does the air become impure, but the temperature rises as high as 90° to 100° F. As no moisture is introduced into these rooms the air becomes extremely dry. For the *weaving* of cotton, on the other hand, moisture is said to be necessary. Weaving-sheds are therefore usually built in damp places: they are low roofed, their height on an average being from eleven to fifteen feet from the flagged floor to the ceiling; the light enters by the roof. The health of the weavers is endangered by impurities in the air, by the products of respiration and the combustion of gas, by cotton-dust and emanations from the soil. The sanitary conveniences for the workpeople are often built too close to the walls of the factory. To these defects must be added excessive moisture of the air in the shed, and a high temperature especially in summer. Within the last forty years, and largely in consequence of the scarcity of cotton during the American War, manufacturers have "sized" the cotton, *i.e.* have passed it through liquid containing starch, china clay, tallow, and such deliquescent salts as magnesium-chloride, to which small quantities of zinc chloride have been added to prevent the growth of mildew. Sizing of the cotton along with excessive humidity of the air has been regarded as a cause not only of discomfort, but of ill-health. During the weaving of the sized cloth a considerable amount of dust is given off. Steam is therefore infused into the weaving-shed with the object of enabling more of the admixture to be woven into cloth and of softening the stiff, oversized threads, thus rendering them soft and pliable and less likely to break. The clothes of the women and young persons who work in the weaving-sheds are frequently so damped by the moisture that on leaving the factory, Dr. Wheatley, formerly M.O.H. Blackburn, says they readily get chilled, become the subjects of rheumatism, and what is worse, of pulmonary disease.

The size itself adds considerably to the dust in the air of the weaving-shed. The amount of dust is determined by the quantity of the size used and the quality of the cotton. Fifty per cent of the dust on the floor and rafters of weaving-sheds was found by Dr. Dupré to be insoluble mineral matter (china clay), 30 per cent insoluble organic matter (cotton), 15 per cent soluble organic matter (starch), and 5 per cent soluble mineral matter (chloride and sulphate of magnesium).

Since steaming in cotton manufacture must be allowed, the humidity of the air in weaving-sheds is regulated by an order from the Home Secretary, which states that the water used for steam must be pure; it also regulates the length and calibre of the pipe that conveys the steam, and it requires that the amount of carbonic acid in the air of the shed must not exceed nine volumes per 10,000 of air. The moisture of the air is tested by a hygrometer. It is difficult to say what is the effect upon health when operatives are obliged to breathe an excessively moist atmosphere for ten hours a day. There is no doubt, however, as to its debilitating effects, and it is probably in consequence of this that tubercular diseases and rheumatism are so frequently met with in cotton weavers. Ventilation has, to some extent, improved matters. Although it is admitted that ·9 part of CO_2 per 1000 of air is not a high standard of purity, yet in order to obtain this it is necessary to introduce as much as 2000 cubic feet of air per head per hour.

While the death-rate of cotton operatives from phthisis is little above that of all males throughout the country, there is a high mortality from pneumonia and bronchitis, from rheumatism and heart disease. Formerly the deaths of cotton operatives in Lancashire from phthisis were 25 per cent of the total deaths (1880-1882), but in the years 1890-1892 these had fallen to 19·6. During the same periods bronchitis and pneumonia showed an increase from 25 to 29·7 per cent.

Flax and Linen

Belfast is the seat of the linen trade. Although the manufacture of linen from flax is a very old industry, it has only been carried on in Ireland for a little over two hundred years.

In the carding and spinning rooms of the factory there is often a great amount of dust, and as the atmosphere is extremely moist and overheated, the workers, especially the half-time doffers, become liable to bronchitis. During the summer months the spinners, in consequence of being on their feet all day and moving about, often without boots, on a wet floor, suffer from œdema of the ankles, onychia, and eczema. Dr. Henry S. Purdon of Belfast found the hands of spinners frequently the seat of eczema rimosum. On the hands of Belgian flax-dressers Dr. Glibert, Medical Inspector of Factories, Brussels, observed a few small round ulcers. Young doffers, *i.e.* the boys and girls who remove the filled bobbins from the spinning-frame, and who replace these by empty bobbins, usually suffer from "mill fever" after they have worked for a few days, an illness which lasts from two to three days, and disappears without treatment. The symptoms of "mill fever" are nausea, vomiting, headache, thirst and feverishness.

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Transfusion.

USES OF 381
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THE transfusion of blood is an operation of some antiquity. History relates that so long ago as in 1492, it was practised in the case of Pope Innocent VIII.

It has been performed from time to time during the last century, and comparatively recently was often employed in severe cases of post partum or other hæmorrhage.

In such cases of sudden hæmorrhage the operation is not called for, and should never be performed. In the infusion of saline fluids we have a simpler and safer proceeding, which satisfactorily fulfils the indication in a sudden and profuse bleeding of filling the emptied heart and vessels, and maintaining the intravascular pressure at a point at which the heart is able to carry on the circulation, until new blood has time to be formed.

There are, however, certain conditions other than sudden hæmorrhage in which blood transfusion may be, and has on many occasions proved itself to be, beneficial. In pernicious anæmia, a condition little amenable to other treatment, sufficient cases have been successfully treated by blood transfusion to encourage further work in this direction; while in certain cases of persistent recurrent hæmorrhage, which were operated upon by the writer, transfusion of blood put a stop to the obstinate bleedings, when all other forms of hæmostatic treatment, local and general, had failed. In these cases the operations which were originally undertaken for the relief of the anæmia resulting from persistent small hæmorrhages, had the unexpected, but undeniable, effect of curing, not only the anæmia, but also the bleeding which had caused the anæmia.

The exact value of blood transfusion in pernicious anæmia, recurrent hæmorrhages, and other diseased conditions, such as septicæmia, must be considered to be still *sub judice:* and it is well to remember that, in judging of such a method, an ounce of unmistakable clinical success is of more value than a ton of adverse laboratory speculation.

The arguments brought against blood transfusion are, firstly, the immediate danger of the operation from the introduction of air, clots, or septic material, and the formation of thrombi, especially in the portal and pulmonary capillaries; and, secondly, the supposed uselessness of the procedure, because of the breaking up of the corpuscles of the blood which has been injected.

With regard to the first objection it may be said that the introduction of air, clots, or septic organisms is due to faulty operative methods, and is avoidable; while the danger from thrombosis, apart from the introduction of palpable clots, is somewhat problematical. With regard to the second objection, it may be the case that the corpuscles break up, and that this event may be followed by a certain amount of fever and hæmoglobinuria: fortunately these occurrences do not appear to be dangerous, or necessarily to interfere with the good effects of the operation. Nothing can be more certain than that the corpuscular improvement noted in several cases of pernicious anæmia has been out of all proportion to the small amount of blood introduced; this improvement, which is often progressive, is evidently due to a stimulation of the blood-forming organs by the new blood thrown in; but in what particular part of the injected blood this stimulant property lies is doubtful; possibly it is in the serum and not in the corpuscles at all.

METHODS OF TRANSFUSION OF BLOOD.—(1) *Immediate Transfusion.*—In this method pure blood is passed directly from the blood-giver to the patient by means of some form of syringe; the instruments of Roussel and Aveling being those most widely known. Immediate transfusion need not be described; it need only be mentioned to be condemned. The risk of introducing clots is very great, while the difficulty of preventing the admission of air and sepsis is considerable.

(2) *Mediate Transfusion.*—Here the blood is defibrinated before injection. The blood being caught in a sterilized vessel standing in hot water (at a temperature of about 105° to 110° F.) is thoroughly defibrinated by whipping, and is then strained through fine muslin into a second warmed vessel; thence it is drawn up into a clean warmed glass syringe, and slowly injected through a short glass and rubber nozzle into the patient's vein. In this method one disadvantage is, that a large quantity of blood is required, a good deal being wasted in the whipping process.

(3) *Transfusion of Blood with Phosphate of Soda Solution.*—As this method is by far the safest and most satisfactory, it will be described a little more fully.

The health of the blood-giver, who should not be beyond young adult life, must be beyond suspicion.

In patients who have suffered from anæmia for some time, the veins are often much diminished in calibre, so much so that, for example, the median basilic vein may scarcely admit an ordinary probe.

In such cases it may be necessary to select some larger vein, such as the saphena, in order to introduce even a fine glass nozzle.

The parts concerned, both in blood-giver and in patient, must be carefully sterilized, and the operation performed aseptically.

A suitable vein having been selected in the patient, it is exposed and two catgut ligatures passed beneath it. The distal ligature is then definitively tied, but the ends are not cut off yet, as they are useful to lift the vein and steady it when opening into its lumen subsequently. The blood-giver is next bled to the extent of from 4 to 6 ounces, in such a way that the blood may fall neatly into a vessel containing the phosphate of soda solution.

This solution is of the strength of 1 to 20. One part of such solution must be mixed with three parts of blood in order to delay coagulation. If the blood appears unusually rich, a rather larger percentage of solution may be advisable.

Two ounces of phosphate solution should be warmed to 105° F., and poured into a flat graduated glass vessel, which should be floating in another basin containing hot boric solution.

The blood-giver is bled direct into the vessel containing the phosphate solution, and the mixture is gently stirred with a glass rod. When the necessary amount of blood (about 6 ounces) has been obtained, an assistant attends to the blood-giver's arm, while the operator now opens the patient's vein, which he had previously exposed, and inserts a small glass nozzle, 1½ inches long, having 1 inch of india-rubber tubing attached to its end. This nozzle must be filled with phosphate solution, and clamped before introduction into the vein, or else air may be admitted. The nozzle is fixed temporarily in place by the first half of a "surgeon's knot," made on the proximal piece of catgut originally passed under the vein. A large glass syringe is now filled with the blood and phosphate solution, and this must be kept warm by wrapping the syringe round with lint wrung out of hot boric lotion. The mixture is then injected into the patient, and great care must be taken (1) to inject very slowly—ten minutes may be taken to empty the 8 ounce syringe; (2) to stop immediately there are any signs of distress, such as dyspnœa or discomfort about the heart: (the pulse should be continually watched).

When the whole of the eight ounces, or as much as the patient can comfortably take, has been injected, the nozzle is withdrawn, the second half of the knot tied, a couple of stitches put in, and the wound dressed in the usual way.

In cases of pernicious anæmia this operation may have to be repeated several times at intervals varying from two to six weeks, according to the patient's progress. It has been frequently noted that improvement, as tested by frequent enumeration of the corpuscles, continues progressively for some weeks, and then halts. It is advisable to operate again when this takes place, the patient in favourable cases being left on a better level as regards his blood after each transfusion, until, after several injections, a normal condition of matters may be reached.

Transfusion of blood into the arteries has been used by Hueter, the object being to avoid the introduction of clots into the heart. As this danger can be avoided by the use of the phosphate of soda method, and as gangrene of the part supplied by the artery employed for the purpose may occur from embolism, the method need not be further discussed.

(4) *Injection of Saline Fluids.*—This procedure has been used with great success after severe hæmorrhage, and in cases of profound shock. It is recommended to be used before or after severe abdominal operations, and has also occasionally been employed in septicæmia, diabetic coma, and post-operative suppression of urine. It is perfectly useless in pernicious anæmia, except as a temporary stimulant.

There are several methods of introducing saline fluid into the circulation,

(*a*) By injection into the rectum.

(*b*) By injection into the loose subcutaneous tissue, *e.g.* of the axillary region.

(*c*) By injection into the veins.

(*d*) By injection into the arteries.

The last of these methods seems to possess no advantages, and some obvious disadvantages, while in regard to the first and second, one must remember that absorption through the vessels of the rectum or subcutaneous tissue can only take place when the circulation is being fairly carried on in the part, whereas intravenous infusion of salines has sometimes a marvellous effect in patients who are almost pulseless.

The saline fluid most commonly used for infusion is a solution of one drachm of common salt in a pint of sterile water at a temperature of about 105° F. Some prefer a solution containing 50 grains of sodium chloride, 3 grains of potassium chloride, 25 grains of carbonate, and 25 grains of sulphate of sodium, with 2 or 3 grains of phosphate of soda, in a pint of water. It is very doubtful if this has any advantage over the simpler salt solution. The fluid is introduced with a glass syringe or funnel arrangement through a glass and rubber nozzle into the patient's vein (special instruments for the purpose have been devised, for example, by Spencer and Collin). The quantity introduced is from ½ a pint to 3 or 4 pints, depending on the condition of the patient and the amount of blood lost. The infusion must be discontinued should the patient show any distress, and, in any case, as soon as the normal pulse tension is regained. The operation must be done very slowly and cautiously, and with aseptic precautions. In cases of hæmorrhage it should only be used when the bleeding has been stopped. The procedure may require to be repeated. It is apt to be followed by a considerable, but transient, rise of temperature. The infusion of milk or of the blood of the lower animals has been tried. These methods are dangerous, and have been discontinued.

Tremor.

THE name tremor has been somewhat loosely given to various forms of rhythmical muscular contraction, which may be widely dissociated not only in their clinical character, but, as far as we can judge, in their physiological or pathological origin. It is customary, for instance, to talk of the tremor of fatigue, the tremor of Graves' disease, or the tremor of disseminate sclerosis. Tremor is not, therefore, a disease, nor, in all cases, a sign of disease, and owing to its widely different character under different circumstances it is not capable of a good pathological or clinical definition. Speaking generally, the term may be said to embrace all the oscillations of a part or of the whole of the body which are rapidly repeated more or less continuously, and more or less regularly without being under the complete control of the will. Such oscillations may recur from two to ten or more times a second. They are all liable to be modified by the will and by the emotions, and in most cases cease entirely under the influence of sleep or of general anæsthetics.

Physiology.—In order to understand the prevailing view of tremor it is necessary to turn for a moment to the character of voluntary muscular contractions and of muscle and nerve tonus. It is impossible to produce artificially a muscular contraction similar to that presented by a willed movement without the application of several rapidly-repeated stimuli, and there are many other reasons for supposing that even a single voluntary movement of a single muscle, such as the blink of an eyelid, is the result of several intermittent discharges of nervous energy. Moreover, physiological experiments tend to show that fatigue produces a diminution in the rapidity with which these discharges follow one another. If these assumptions are correct, voluntary muscular contractions are *naturally* rhythmical in character, and the close association of muscular tonus with muscular activity would lead us to believe that tonus itself is the result of intermittent impulses flowing in a continuous stream, under normal conditions, from living nerve cells, and capable of modification by various influences acting upon these cells. These physiological considerations are not calculated in the present state of our knowledge to explain the tremor of disease, but they enable us to put it in line with the natural activity of nerve and muscle, and to show that there is probably a very close relationship between tremor, hypertonicity, and spasm, a relationship which may perhaps depend on variations in the amplitude and the rapidity of the so-called nervous discharges.

Clinical.—It has been customary to divide all tremors into two classes and to classify them under the terms "passive tremor" and "intention tremor," but this classification is unscientific and leads to many fallacies in practice. We find, for instance, that the tremor of disseminate sclerosis, although generally brought into notice by the attempt to perform some voluntary action, is often present while the patient is at rest, and that many passive tremors, such as that of paralysis agitans, may be remarkably exaggerated by voluntary exertion. If it were possible we should prefer to classify tremors on a scientific pathological basis, but our knowledge of their pathology is too scanty to permit of this course, and we shall therefore attempt a scheme of classification dependent on the conditions under which tremor is liable to occur. This method has the advantage of bringing together types of tremor which are similar not only in their clinical characters, but very probably also in their origin.

Psychological . .		1. Emotion.
		2. Hysteria.
Physiological . .		3. Heredity.
		4. Senility.
		5. Acute fatigue.
		6. Chronic fatigue.
		7. Cold.
Pathological . .	(A)	8. Toxæmia.
		9. Metallic poisoning.
		10. Chronic narcotism.
	(B)	11. Neurasthenia.
		12. Rheumatoid arthritis.
		13. Paralysis agitans.
		14. Exophthalmic goitre.
	(C)	15. Disseminate sclerosis.
		16. Lesions about the mesencephalon.
		17. Spastic conditions generally.

Psychological.—The tremors of emotion are too well known and too variable to admit of detailed description, but it may be noticed that they are more often excited by the unpleasant conditions of terror and anger than by more pleasurable states of mind. The tremors of hysteria are generally irregular, inconstant, often confined to one limb or part, and always worse under observation. They may be fine or coarse, but are more often coarse and moderately slow than fine and rapid.

Physiological.—The hereditary and senile forms of tremor, like those of grey hair and arterio-sclerosis, are closely associated one with the other, and appear to be the visible signs of some premature tissue decay to which the family or the individual is especially prone. The hereditary form generally appears after twenty years of age, and resembles the senile form in being rather fine in character and in affecting most frequently the muscles of the upper extremity and of the face and neck.

All forms of severe exertion may cause a temporary state of tremulousness, which must be familiar to every one, and which is especially noticeable in the attempt to carry out a fine movement, such as that of writing. On the other hand, the constant daily use of certain muscles, perhaps in constrained positions, is a prolific source of tremor in connection with the different forms of occupation neurosis. Miners' nystagmus and certain cases of writer's cramp are good examples of this, and the latter condition serves to show how closely spasm and tremor are associated not only in organic but in functional disorders of the neuro-muscular system. Exposure to a rapid fall of temperature is liable to set up momentarily a form of tremor especially affecting the muscles of the head and trunk, of which the most common type is known by the name of "teeth-chattering."

Pathological.—(A) Many specific fevers both in the acute stage and in the debility of convalescence may give rise to tremors of the extremities and of the tongue and lips. It is impossible to say how far the rise of temperature or how far the circulating toxins are responsible for this result, but it is probable that both have a deleterious influence on certain nervous structures, of which the tremor is the outward expression.

Tremor is often an essential element of a rigor, and is not unfrequently associated with pain and an elevation of temperature in cases of renal and other forms of colic.

A morbid entity consisting of severe paroxysmal attacks of tremor accompanied by loss of consciousness and some fever has been described, but little is known of this rare condition except that the prognosis appears to be favourable.

Syphilis in its more remote influence on the nervous system is sometimes productive of tremor, and the early diagnosis of general paralysis of the insane is often rendered easy by the very characteristic tremor of the lips and tongue, which may be very noticeable, and which doubtless largely contributes to the peculiar articulation observed in these patients.

Lead, mercury, arsenic, copper, and zinc are responsible for most cases of tremor due to metallic poisoning, and the symptom is most commonly present in the upper extremities and sometimes in the muscles of the face. The oscillations are usually fine and rapid, but in some mercurial cases coarse movements affecting the whole body are met with.

As is well known most narcotics are primarily stimulants, but the tremor which is produced by their habitual abuse must be accounted a symptom of the secondary narcotism, and it is interesting to note that the tremor of a chronic alcoholic subject or of a morphomaniac may be temporarily controlled by a dose of alcohol or of morphia, the tremor reappearing as the stimulative effect of the dose wears off. Alcohol, morphia, and tobacco are the best known members of this group of poisons, but a fine tremor of the extremities is also common in patients suffering from bromidism.

(B) The four diseases, neurasthenia, rheumatoid arthritis, paralysis agitans, and Graves' disease, are purposely placed together because they appear in more ways than one to be related, and to belong to a group of which the pathology is still obscure. The tremor of some neurasthenics is extremely suggestive of Graves' disease, and some cases of rheumatoid arthritis resemble paralysis agitans in having either a hemiplegic or diplegic distribution of tremor, which combined with the rigidity caused by joint troubles gives the patients a strong resemblance to cases of Parkinson's disease. Moreover, all four diseases present trophic disorders of skin, nails, etc., which can hardly fail to attract attention as being of practically the same kind. The tremulousness is, in the first instance, always limited to the extremities in these diseases. The tremor of paralysis agitans deserves a little more attention in that it serves as a good general example of the phenomenon. The movements are repeated from three to seven times a second, and their size and rapidity varies with the size of the muscle affected. In some cases the most prominent movement is that of the thumb against the first finger (cigarette-rolling), and the oscillations may be fine and limited in extent. Another common rhythmic action is that of alternate pronation and supination of the wrist, and then both the intermittence and size of the movement is greater. Only in more advanced stages of the disease does the tremor attack the proximal parts of the limbs and the muscles of the head and trunk, which are generally the seat of great rigidity.

(C) The diseases of the last group are alike in presenting well-known anatomical lesions of the central nervous system, and in being characterised by spasticity and tremor of varying degree and severity. The tremor in each case is called into existence or exaggerated by efforts of voluntary activity, and is of a coarse and not very co-ordinate type. A spontaneous ankle clonus occurring in an extremely spastic patient is a good specimen of this kind of tremor, which can hardly be placed in the same category as, and deserves a different name from, the finer movements seen in exophthalmic goitre or chronic alcoholism. The rate of the oscillations in disseminate sclerosis varies from four to eight per second, but the excursions of the affected limb are not of constant size.

Certain cases of hemiplegia and of diplegia present a form of intention tremor which cannot be distinguished from that of disseminate sclerosis, but we are still ignorant of the anatomical basis for this phenomenon; it can only be said that disease in the mesencephalic region of the brain appears to be most frequently associated with it.

Diagnosis.—A knowledge of the conditions under which tremor occurs is of great practical value, but the diagnosis of a disease can rarely be made from the character of the tremor alone in any particular case. It is true that the tremor of paralysis agitans is very characteristic in many patients, but it is usually associated with such an unmistakable picture in other respects that even its absence would not discount the diagnosis.

All other forms of fine tremor are not easily differentiated on their own merits, and the coarse intention movements of disseminate sclerosis may not infrequently be seen in cases of hemiplegia, diplegia, or cerebral tumour. The accompanying signs and symptoms must, therefore, be always carefully considered before arriving at any definite conclusion.

Pathology.—Enough has already been said to show that our knowledge of the morbid process concerned in the production of tremor is too insufficient to allow of any dogmatic statements to be made on this point, but it must be granted that in many cases the phenomenon would seem to result from the action of poisons on some part of the motor neurons, and probably on the cellular part of those structures. It may be inferred, too, from a consideration of the diseases in which some forms of tremor occur, that the same nervous elements are influenced by the altered metabolism associated with degenerative processes as in fatigue and senility, or with modified conditions of internal secretion, as for instance in Graves' disease, and possibly, according to some authors, in paralysis agitans. It is not safe, however, to do more than suggest the possibility of this connection.

Treatment.—In most cases the treatment of tremor is the treatment of the disease of which it is one of the physical signs; in others, such as paralysis agitans, where it is often a source of great distress to the patient, attempts directed to its alleviation are seldom very successful. Injections of hydrobromate of hyoscine are sometimes helpful in reducing the severity of the condition, but most other sedatives are quite ineffectual. Galvanism may at times be used with advantage, and the administration of thyroid gland in small doses, gradually increased, is worthy of trial.

Fibrillary Tremor.—This condition should not, except for its name, be mentioned in this connection. The name has been applied to waves of contraction which can be seen passing over the individual fibres of a muscle in an early state of degeneration in cases of neuritis or of progressive muscular atrophy, and which do not result in movements of the parts affected. They are usually made more noticeable by the exposure of the overlying skin to cold air, as in stripping the patient, but are unimportant except for purposes of diagnosis.

Trichiniasis. *See* Parasites.

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The enormous extent of the field which hot climates offer for the clinical and pathological study of febrile diseases may be estimated by a glance at the annual returns of the Government of India. In 1899, which was an unusually healthy year, no fewer than 4,072,750 deaths, exclusive of those caused by the exanthemata, were registered under that heading. In other years the number has reached four and a half millions (1892) in a population of 250,000,000; and remembering the very imperfect registration of mortality in that country, where it is probably no exaggeration to say that a fourth of the deaths are not registered at all, and that in the native army and jail population, from which we obtain exact returns, the case mortality from these diseases (including hepatitis, pneumonia, and other inflammatory diseases, which are all massed together with "fevers" in those of the general population) is only 10 per 1000, one can form some conception of the amount of sickness which these figures represent and of the field which they offer for study. Out of a total registered mortality of 29·5 per 1000, 19·5 are entered under this head, and it may be said that in India—and there is no reason to think that India is exceptional to other hot countries in that respect—of every three cases which present themselves for treatment two are suffering from fever of some kind.

Fevers have, accordingly, always loomed large in writings descriptive of tropical diseases, and the history of tropical medicine is naturally largely that of the disentanglement of this mass of fevers and the gradual differentiation of clinical types.

Putting on one side malarial fevers of the intermittent and "remittent" forms, typhoid, Malta, relapsing, filarial fevers, and the exanthemata, there remain a large number of cases which refuse to range themselves under any of these headings. These may be subdivided into the following clinical types:—1. Continued fevers of short duration; 2. Continued fevers of longer duration and more or less definite course; 3. Periodic fevers of long interval; 4. Fevers of uncertain and probably mixed origin.

Continued Fevers of Short Duration

Writing in 1857, J. B. Scriven (*Indian Annals of Medical Science*, vol. iv. 1857) was able to recognise four essential kinds of fever in Bengal, exclusive of the exanthemata, namely,—1. Malarious fever, divided into continued, remittent, and intermittent; 2. Febricula or ephemeral fever; 3. Insolation or sun fever; 4. Typhoid fever. This classification took firm hold of the profession, and received the sanction of such great teachers as Maclean and Chevers. It was simple and comprehensive, but the lumping together of continued, remittent, and intermittent fevers under the heading of "Malaria" has greatly retarded the progress of tropical pathology. The difficulty of grouping together fevers offering such diverse clinical pictures was not unperceived, but the early defervescence of those of a short continued type was believed to be due to treatment. Writing in 1886 Chevers (*Diseases of India,* page 216) says:—"Assuredly he who in Bengal proper treats all cases of ordinary fever (excluding jungle fever, enteric, and the exanthemata) with quinine, as soon as perspiration shows itself after the first paroxysm, will find that febricula is a very ephemeral disease indeed, and that his experience of common continued fever is extremely small. I am confident that these three diseases, or, to speak more accurately with Dr. Morehead, these three degrees of the same malady, are in Lower Bengal the most usual types in which intermittent fever first attacks the robust, full-blooded, and perhaps free living European who arrives there during the hot weather." The fallacy incorporated in these remarks is that ephemeral fever, febricula, and simple continued fevers, are fevers of a single paroxysm of a few hours' or days' duration, and that there is no tendency to recurrence of the paroxysm whether they are treated with quinine or not. If they show any tendency to a repetition of the paroxysm this must be taken as evidence that they are of a different type, and due to malarial infection, when quinine in full doses becomes the appropriate treatment; but I have treated many hundreds of such cases without the exhibition of a single grain of quinine, and without their showing any tendency to the manifestation of the phenomena of the life-cycle of the malarial parasite.

This is the commonest type of fever, not only in Lower Bengal, but also in Burma, and it is probably so equally in other parts of India. That these fevers do not take the first place in the returns of the Government of India is due to two circumstances: first, because cases of fever of such short duration are not necessarily admitted to hospital; and, secondly, because there is a strong tendency, especially in the native army and jails—such is the result of the teaching of which I complain—to return all cases of mild fever of short duration as "ague." These returns indeed do not show the existence of ephemeral fever or febricula at all, the commonest forms of fever with which the practitioner in civil life has to deal. Thus in the Alipore jail in 1899 the admission rate for "simple continued fever" (probably including all the milder expressions of single paroxysm fevers) was 373·7 per 1000 of population, against 74 per 1000 for "intermittent" fever; whereas in the Presidency jail, a mile distant, the returns would indicate 2·5 and 299·3 per 1000 respectively. The difference between the returns of these neighbouring institutions is indicative of the personal element in classification, and it must be admitted that such returns are valueless as an index to the relative prevalence of these mild fevers of a single paroxysm, and true malarial fevers. This can only be arrived at by a systematic examination of the blood.

These three fevers, or rather these three degrees of the same fever, differ not only in duration, but in intensity. When the duration is only a few hours, and the intensity is slight, it is called "ephemeral" fever; when it lasts some forty-eight hours it is spoken of as "febricula"; and when its continuance is longer, from three to eight or ten days, when the temperatures usually vary from 102° F. in the morning to 103° to 104° in the evening, it rises to the dignity of "simple continued fever." Quinine in full doses has no appreciable effect either on their duration or course. They subside spontaneously by lysis, and in the warm humid climate of Lower Bengal are often accompanied by much visible perspiration throughout their course, which is absent in the hot, dry atmosphere of other parts of India where evaporation from the surface is active. The occurrence of such perspiration does not, however, as in true malarial fevers, mark the advent of any terminal "sweating stage."

When the intensity is greater, and the temperatures reach 107° to 109°, other phenomena, characteristic of hyperpyrexia, intervene, of which a flushed face, rapid breathing and pulse, intensely hot, generally dry skin, injection of the conjunctiva, delirium, convulsions, and coma are the most constant. This is the "thermic fever," "heat apoplexy," or "insolation" of systematic writers. It differs from the other three only in intensity, and the prodromal symptoms, which have been insisted upon as an indication of some specific infection—the disinclination for exertion, the headache, anorexia, nausea, and hot dry skin, etc. which precede the distinctive hyperpyrexia, are precisely those of the milder forms, and are preliminary to the final, often sudden, giving way of the thermic control, of which the post-mortem appearances, the pulmonary and cerebral congestion, and heart failure are the natural expression. There is no essential difference between the phenomena of "febricula" and "heat apoplexy." It is merely one of degree.

With regard to the causation of this class of fevers the influence of climatic conditions cannot be denied. They require for their prevalence a high maximum daily temperature and an unclouded sky—solar traumatism being evidently the most potent factor—or an atmosphere laden with moisture. To demonstrate the effect of these conditions it is only necessary to "plot out" the admission-rate per 1000 for each month of the year for "simple continued fever," in two such different climates as those of Lucknow and Rangoon (making every allowance for errors in nomenclature).

The months of highest maximum temperature in Lucknow are March, April, May, and June. These are also the months of highest admission-rate for "simple continued fever." In June, with the advent of cloudy weather preceding the burst of the monsoon rains in July, the admissions are fewer than in May, when there is nothing to veil the fierce heat of the sun. With the arrival of the rains there is a drop both in the admissions and in the atmospheric temperature, which never again rises above that of the body. In Rangoon, on the other hand, the hottest months are February, March, and April; and January, February, and March give the greatest number of admissions. In that part of Burma the monsoon breaks in May, and the rains are preceded and accompanied by cloud-laden skies, and during their continuance admissions for "simple continued fever" disappear from the returns. With the cessation of the rains in September admissions again take place in October.

An atmospheric maximum in the shade of 100° F. or more seems to be most conducive to the prevalence of this type of fever, and I have elsewhere pointed out (*Transactions of the Medical Society of London,* 1902) the difficulties which present themselves to the maintenance of normal temperature under conditions of high atmospheric temperature and humidity. This has also been shown experimentally in artificially heated chambers, the introduction of moisture immediately causing a rise of body temperature, which may then exceed physiological limits by many degrees, and I have also shown (*Indian Annals of Medical Science*, vol. xxxii. of 1874) that slight exertion in the conditions which prevail in India during the hot, moist months is capable of raising the body temperature to 99·9° F. The experience of troops on the march, unsuitably clothed and carrying weights, is to the same effect, and many men fall out under such circumstances with short febrile attacks. These phenomena show that the immediate cause of these fevers is probably failure of the control which is normally exerted by the nervous system in maintaining normal temperature when thermolysis is next to impossible, the atmospheric temperature being higher than that of the body, and evaporation from the surface hindered by great atmospheric humidity and heavy clothing. It is under such conditions that "heat-apoplexy," as distinguished from "sunstroke," so constantly occurs, the attack frequently occurring in the evening after sundown. Chills are also often noticed as the immediate cause of the symptoms, especially in individuals whose nervous system has been exhausted by long exposure to heat or impaired by the free use of alcohol. Alcoholics are indeed the most frequent subjects of these climatic fevers, especially heat-apoplexy. Europeans are much more liable to them than natives, and I do not think that long residence gives any immunity except such as may come from greater caution, the result of the teaching of experience.

Such are the conditions under which these fevers are most frequently seen, but it by no means follows that they constitute the whole case. With regard to the fourth member of the group, which Sambon prefers to call "siriasis," notwithstanding the etymological incongruity of the name, the capricious distribution of the disease, its varying prevalence in the same place from year to year, its apparent epidemicity at times, and its more or less definite course, have led him to argue that it is probably a specific fever due to some infecting germ, and similar arguments might be used with equal force to the other members of the group. The strongest evidence in this direction is, however, the fact that individuals, and especially children, who have come to reside in a temperate climate after a long residence in the tropics, where they may not have had any obvious fever, often exhibit a strong tendency to the occurrence of fever of this type for some years. Even those who are the subjects of the malarial cachexia contracted in the tropics, in whom the spleen often remains enlarged for many months after their return to Europe, suffer more often from a "febricula," an elevation of temperature for a few hours, on the smallest provocation, than from fever of an intermittent character. Each of those attacks is accompanied by a fresh enlargement of the spleen, and their liability to them continues until the spleen, from the effects of treatment, notably with arsenic, has assumed its natural size.

I know of no observations on the blood in these cases except those of Maynard and myself. In February and March 1895, the least malarious season in Calcutta, I found the malarial parasite present in less than 10 per cent of the cases of fever admitted to the European General Hospital. Maynard, working a few months later, found it in 28 per cent of admissions. From September to November, the most malarious season, they were detected in 75 per cent of all cases admitted to hospital. The rapid recovery of typical cases of this kind without quinine, the refusal of the more persistent cases to yield to that drug, and the absence of symptoms referable to the life-cycle of the parasite, lead to the opinion that its presence is accidental, and that it plays only a secondary part in the causation of fevers of this kind; and until extended and exhaustive bacterial research has been brought to bear on this group of fevers, the propriety of admitting them to the class of specific fevers must remain doubtful.

Nasha or Nakra.—Nasha or nakra (*nak* = the nose) is a continued fever of from three to five days' duration, accompanied by tumefaction of the nasal mucous membrane. It is also a fever of the hot months, being rarely seen except between April and August. It is especially prevalent in Lower Bengal, and appears to affect natives only, males more than females, and children never. It is treated by local blood-letting by puncture of the swollen mucosa. It appears to cause considerable distress, but seldom gives rise to any anxiety. It is very doubtful whether it deserves to have a place as a specific fever, the nasal symptoms, which are diagnostic, being regarded by many merely as a local catarrh grafted on an ordinary febricula. An interesting discussion on this fever will be found in the *Transactions of the First Indian Medical Congress*, 1895.

"*Low*" *Fever.*—"Low" fever is a condition which seems also to be due to a climatic embarrassment of the heat-regulating centres, and differs from the other members of this group by its indefinite duration, which may cover a period of weeks and months without the development of any specific symptoms. It is characterised by a persistent low elevation of temperature, beginning insidiously with slight general malaise and anorexia. The temperature ranges from 99° in the morning to 101° or 101·5° in the evening, and it may continue for many weeks unaffected by quinine or arsenic pushed to extreme doses, or by any medicinal treatment, but generally yields at once when the patient is removed to more favourable climatic conditions. A case which has resisted all treatment for two months will get well immediately on a change to the "hills," or to sea, or even from one part of the same town to another. Cases have been known to persist for eight months, the patient continuing to follow his usual avocations until gradual loss of strength forces him to take the necessary change. It is not contagious, no other member of the family being attacked, though the patient mixes freely with them. If it were due to a specific organism, it would run a more definite course, and "change" would not have the immediate effect which follows it. This fever is not of great frequency, but it is sufficiently differentiated clinically to merit special bacteriological investigation.

CONTINUED FEVERS OF LONGER DURATION AND MORE DEFINITE COURSE

Bastard Typhoid.—Instead of resolving in eight or ten days, certain cases of what may at first be regarded as "simple continued fever" run on to twenty-one or twenty-eight days. Their course is that of mild typhoid, but they do not manifest any of the clinical symptoms which are diagnostic of that disease. There are no spots, no pea-soup or other diarrhœa, no gurgling in the right iliac fossa, no delirium, and no marked tendency to adynamia. The spleen is not perceptibly enlarged, or if it is, this in a malarious country is of little diagnostic value. The temperature curve is that of mild typhoid. These cases are met with chiefly in the cold and early hot seasons, the seasons of typhoid prevalence, and they occur most frequently in individuals who have only been a short time in the tropics, as happens also with true typhoid. Their course is uninfluenced by quinine, they show no sign of periodicity, and you look in vain for the malarial parasite. They are met with oftenest in large cities, and there with such frequency that they have received local names, as "Calcutta fever" in Calcutta, "Bombay fever" in Bombay, etc., and for that reason I have distinguished them (*Brit. Med. Jour.*, 24th September 1898) as "urban continued" or "bastard typhoid" fever. There is very little doubt that they are really mild cases of typhoid fever, and the diagnosis could easily be established by the Widal test, as this fever occurs chiefly in Europeans. I am not aware that this has yet been done in India, but similar cases in South Africa have given a positive reaction in 75 per cent of those examined in this way. In one case of this kind under my observation there was sharp hæmorrhage from the bowel, but in the absence of diagnostic clinical symptoms of typhoid, practitioners in tropical towns have hesitated to include them under that name, having in their minds the possibilities of other bacteriological infections by other members of the coli group.[1] It is not improbable, as I have suggested elsewhere (*Transactions of the Clinical Society for* 1901, vol. xxxiv. p. 127), that we are dealing here with the true "bed-rock" of typhoid fever, and that these cases are really due to a pure infection by the bacillus of Eberth, the characteristic phenomena of the clinical picture presented by typical typhoid being due to "mixed infection" from the admission to the blood of other organisms, and that it is these, strengthening and modifying the action of the bacillus typhosus, that give rise to the diagnostic features of typhoid, which are absent in the cases I am discussing. The experimental work of Sanarelli and Rémy add great weight to this view. They found that the addition of the B. coli communis to a culture of B. typhosus increased its virulence, and at the same time materially altered its cultural characters. The varying features presented in different epidemics of typhoid, the comparative frequency of thrombosis and muco-colitis, and the profuseness of the eruption, in South Africa for instance, are also in favour of such a theory. In view of these considerations it might be well to retain the name of "bastard typhoid" to designate cases which run the course of typhoid without its characteristic symptomatic and pathological phenomena.

Double Continued Fever.—Manson (*Tropical Diseases*, p. 247) mentions a form of continued fever which he encountered in South China, both in Amoy and Hong Kong, "characterised by an initial pyrexial stage of from ten days' to a fortnight's duration, followed by a stage of from three to seven days' relative or absolute apyrexia, which, in its turn, was succeeded by another spell of about ten days' duration of smart fever, and then by convalescence. Both in the primary and in the terminal fever the evening temperature may rise to 104° or 104·5°." There are no special symptoms, nor any special complications, as far as has been observed—the double fever being constant and characteristic; and the same succession of events may occur almost, in one instance quite, simultaneously in two patients living in the same house. Relapses of "simple continued fever," such as I have described in the first section of this paper, are of the rarest occurrence, and we may therefore assume that in the cases mentioned by Manson we are dealing with a specific infection of an altogether different character. I have not met with instances of this fever in India.

Non-Malarial "Remittent" Fever.—There, however, occurs in the tropics a fairly frequent form of continued fever which presents a very close clinical resemblance to the malignant type of malarial infection, with which it has been long, and is still confounded, though distinctions force themselves on the observation of attentive practitioners. The first point of distinction is that the spleen does not enlarge in these cases, or only in a very minor degree; and, second, quinine given in heroic doses does not in the smallest degree affect the course of the fever, but only adds materially to the distress of the patient; thirdly, the most careful and repeated search for the malarial parasite fails to find it. It is a continued fever of great severity running a definite course of about six weeks, and showing occasionally a tendency to relapse after an apyrexial period of about a week, the relapse being of the same type, but usually shorter and milder. It is more common in natives than Europeans, and children frequently suffer, while it is seldom seen after thirty years of age. It is called "remittent" because of its resemblance clinically to the "remittent" forms of malarial fever, but it is really a continued fever, and evidently due to some specific infection.

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[1] *Vide* articles on "Paratyphoid Fever," *American Journal of Medical Sciences*, Aug. 1902.

The attack often begins with distinct intermissions, as happens also with typhoid fever in the tropics, probably from the accidental presence of malarial parasites in the blood (Laveran), but after the first two or three days, notwithstanding large dosage with quinine, the fever becomes continued, and rapidly reaches continuous high temperature, 104° and 105° being the rule after the fourth day, with a remission of not more than 1·5° in many cases, though in others it amounts to 2° or 2·5° at some part of the twenty-four hours. With this continuance of high temperature, head symptoms are early and severe, with delirium and coma. The size of the spleen remains little altered, but the liver is early affected, becoming enlarged and congested, and a bilious diarrhœa, perhaps with slight jaundice, is the rule. From the eighteenth to the twenty-fourth day congestion of the backs of both lungs will generally be detected, and death is not uncommon about this period. In more favourable cases the symptoms gradually subside, and in another fortnight the attack is at an end. The firm belief that these cases are a form of malarial fever leads to treatment by repeated full doses of quinine, but without any benefit, and the distress which its indiscriminate use in these attacks causes has done a great deal to bring about the dread with which natives regard that drug, a dread which often prevents its effective use in other cases in which its beneficial results would be so conspicuous.

The question as to the true nature of the infection in these cases of non-malarial "remittent" has to some extent been answered by the discovery first made by Professor Wright of Netley and Surgeon-Captain Smith, that many convalescents from India give a positive reaction to the serum segmentation test for Malta fever (*Brit. Med. Jour.* of 10th April 1897), and this reaction has since then been found to occur in India in many cases which formerly would have been regarded as malarial (Bamber, *Ind. Med. Gaz.*, Nov. 1900). I am not aware, however, that the *bacillus Melitensis* itself has yet been obtained from any fatal case of this fever, and looking at the wide divergence which the clinical symptoms exhibit from those of the typical course of Malta fever, and the absence of the sequelæ which are so characteristic of that disease, and the uncertainty as to the signification of the results of the serum test, I would, in the absence of detailed cases, join with Manson (*Lancet* of 23rd August 1902, p. 544) in advising caution in accepting such evidence as conclusive as to the prevalence of Malta fever in India.

Similar remarks apply with still greater force to the recent discovery of the presence of Widal's reaction in the blood of natives of India suffering from obscure attacks of continued fever, which has been advanced to prove that the belief that natives of India are comparatively immune from enteric fever must be abandoned, and that many attacks of this nature are in reality due to infection by the bacillus typhosus. Surgeon-Captain Freyer was the first to sound a warning note as to the doubtful diagnostic value of Widal's reaction in the examination of native blood. In dilutions of "about 1 in 12" he found—without mentioning a time limit—a positive reaction in the blood of sixteen out of eighteen specimens examined in healthy natives over two years of age (*Brit. Med. Jour.*, 7th August 1897, p. 329). Lamb of Bombay, applying the sedimentation test, failed to confirm Freyer's results (*Ind. Med. Gaz.*, April 1901, p. 123); but out of eleven specimens taken from natives of India resident in London, in good health, and with no history of a recent attack of fever of any kind, a positive result by the microscopic method was obtained in seven instances, in dilutions of 1 in 50. Three of those whose blood failed to give any reaction were over forty years of age, and only one of eight below thirty failed altogether to show the presence of agglutinins. In four of these a well-marked reaction, which would have been sufficient in Europeans to establish the bacteriological diagnosis of enteric fever, occurred within half an hour; in the others it was more belated. It is clear, therefore, that conclusions based on the serum test in natives in India must be accepted with great caution, and though enteric fever may be of more frequent occurrence in some parts of India, as in Bombay and Poona (Lamb, *l.c. Ind. Med.*, *Gaz.* February 1902), and in Madras (Elliot, *Ind. Med. Gaz.*, March 1901, p. 115), especially though not exclusively in native Christians, Goorkhas, Burmans, and other natives who have abandoned a strict non-alcoholic and non-animal dietary, the belief in a comparative immunity from enteric fever enjoyed by natives on the whole, which is founded on the evidence of post-mortem examinations in the jails and large hospitals of India, remains unshaken (*vide Ind. Med. Gaz.* of May 1893). It argues rather a narrow view of the possibilities of bacteriology—a science still in its infancy—to limit our conceptions to those infections which are already known. It was this limitation which so long led clinicists to confound Malta fever with malarial and enteric fevers in spite of its well-marked and distinctive clinical symptoms.

RECURRENT FEVERS OF LONG INTERVAL

The malarial parasites are organisms which have life-cycles of twenty-four, forty-eight, and seventy-two hours, giving rise to quotidian, tertian, and quartan ague respectively, and their life-history is incompatible with a regular recurrence of fever at longer intervals, and it is in our present state of knowledge impossible to ascribe to these organisms those fevers which are marked by a regular recurrence at intervals of a week, a fortnight, or a month. The regular recurrence of "relapsing fever" after a week of apyrexia has been found to be due to the *spirillum Obermeieri;* and "elephantoid fever" (an uncouth name which should now be abandoned in favour of "filarial fever"), with its regular recurrence, in typical cases, at intervals of a month, with its rigors, high temperature, and lymphangitis in those parts destined to be the seat of elephantiasis, is unquestionably caused by the presence of the filaria Bancrofti; but the cause of a fever, with a fortnight's interval without any specific phenomena except enlargement of the spleen, is as yet unexplained. These cases are of sufficient frequency to mark a distinct fever of specific causation. In the writer's experience the patients have mostly resided in the valley of the Brahmaputra, and have been the subjects of a fever coming with the greatest punctuality every fourteenth day. If the first attack occurs on a Thursday the subsequent attacks are on every alternate Thursday for two or three months, the febrile paroxysm lasting twenty-four to thirty-six hours. In the interval the patient is free from fever, but after several attacks the spleen will be found to be considerably enlarged, and ultimately all the phenomena of the malarial cachexia manifest themselves. We know of no modification of the known malarial parasites capable of causing a fever of this character, and the punctual regularity of the recurrence precludes the idea of accidental infection by them. It suggests infection by some organism with a life-cycle of fourteen days, possibly a hæmamœba of a yet unnoted kind. Quinine in full doses has in my experience invariably broken the sequence of events.

Fevers of Mixed Origin

Typho-Malarial Fever.—In the tropics the combination of malarial infection with that of typhoid serves to obscure the early symptoms of enteric fever, giving rise in many cases to a violent and sudden access, instead of the gradual step-like rise of temperature which is so characteristic of it in temperate climates, and in such cases convalescence is often delayed by several days of intermittent fever, when the course of the typhoid symptoms appears to have ended. At these initial and terminal stages the malarial parasite may be detected in the blood. It was in such cases of "congestive" or "adynamic remittent" fever that the older writers remarked the presence of ulceration or congestion of the small intestine in post-mortem examination (Annesley, *Diseases of India and Warm Climates*, 1828, and Twining, *Diseases of Bengal*, 1835). Otherwise the ordinary course of typhoid fever is little modified by this combination with malaria, and I do not think that it is entitled to a separate place in nomenclature. In many cases diagnosed as typhoid fever in the tropics, the post-mortem appearances are by no means characteristic (*vide Annual Reports of the Government of India*, and my *Report on the Fevers of Burma*, 1876), but this argues a "mixed infection" with some other bacillus, rather than with a hæmamœba.

Kala-Azar.—This is a very fatal malady, which for the past fifteen years has been devastating portions of Assam, especially in the district of Goalpara, a low-lying malarious district between the Brahmaputra and the Garo Hills. It has been investigated by Giles, Rogers, and Ronald Ross. It is characterised in its advanced stages by extreme anæmia, great and progressive debility, intercurrent attacks of fever, enlargement of the spleen and liver, darkening of the complexion, and dropsy. Except during the intercurrent attacks of fever, the temperature is markedly subnormal, as in other anæmias. Two views are taken of its essential nature. Giles, finding the ova of the ankylostoma duodenalis present in the fæces of practically every case he examined, regarded kala-azar as essentially an ankylostomiasis, and the concomitant signs of malaria as accidental and only constant because of the highly malarious surroundings of those affected. Rogers and Ross take the opposite view, and look on the malarial infection as essential, and the ankylostomiasis as accidental. They found the malarial parasite present in the blood in all early cases, and that at that period the disease was undistinguishable from ordinary malaria, except, according to Rogers, that the parasite was of unusual virulence. There is no doubt that the ankylostoma is exceedingly prevalent in other parts of India where kala-azar is unknown; but there are few districts which combine so great a prevalence of this parasite with so virulent a form of malaria as exists in the parts of Assam decimated by kala-azar, and pending further study of this disease it may with fair reason be attributed to this combination. This is the view expressed by Giles himself (*B. M. J.*, 26th March 1893). The best results of treatment are obtained by the early use of quinine and thymol.

Hæmoglobinuric Fever.—This is the "Blackwater fever" of tropical Africa. It has also been reported in the hotter parts of America, the West India Islands, the Eastern Archipelago, in the south of Japan, in Assam, and in other districts of India. It is also met with in southern Europe, Greece, Italy, and Sardinia, in Algeria, and in the Koomati Poort district of South Africa. It is certainly not prevalent generally in India, and it is by no means clear from the reports received that the observers have always been careful to distinguish between hæmoglobinuria and hæmaturia. It is hardly possible that a fever with so marked peculiarities could escape notice, and the returns of the large hospitals of India are silent with regard to it. It may be that a recent introduction of the infective germ has taken place, just as is believed by many to have occurred in tropical Africa itself.

It is characterised by pyrexia, which is ushered in by rigor, bilious vomiting, with icterus, hæmoglobinuria, and diminution in the quantity of urine. It is extremely fatal, the deaths being in the proportion of 75 per cent of attacks. The pathognomonic symptom is strongly suggestive that the infective organism is related to the *Pirosoma bigeminum* of Texas cattle fever, in which hæmoglobinuria is also the constant symptom, but as yet all attempts to detect this or any other specific organism in man have failed. (See also "BLACKWATER FEVER," vol. i.)

Its association with malaria is undoubted. All the endemic areas in which it is met with are noted for malaria of a severe and virulent type. This is true of those districts of India where it has been reported, and also of Koomati Poort, the last addition to the list. It usually occurs in individuals who, being residents in these areas, have had several previous attacks of ordinary malarial fever, and it is unusual in the first year of residence, being most frequent in the third year. It may, however, occur without any previous attack of malaria; of this many instances have now been recorded. At the beginning of the attack parasites undistinguishable from those of a mixed malarial infection will be found in the blood, belonging generally, but not necessarily, to the malignant crescent-forming type. On the appearance of hæmoglobin in the urine these generally disappear from the blood, although quinine may not have been given, and this may terminate a chronic malarial infection.

Two explanations would seem to be possible of these phenomena. First, that the occurrence of hæmoglobinuria is due to the addition of a distinct specific infection, of less frequency than, and inimical to, the malarial parasite, destroying it along with its containing red-blood corpuscles; or, secondly, it may be due to a special virulence of the toxin formed by the malarial parasites, which not only destroys the corpuscles which they inhabit, but is also fatal to their own existence. In the present state of our knowledge the latter is the more likely hypothesis, which would, however, be immediately set aside by the discovery of a specific infective organism.

Koch's idea that the cause of the hæmoglobinuria is the quinine given to cure the malarial infection cannot be entertained; in the first place, because it may occur, with a fatal result, in cases in which the drug has not been given, and in the second place, because quinine may be given, and is constantly given in heroic doses, in districts where hæmoglobinuric fever is not endemic without its ever inducing hæmoglobinuria. In my own experience in Lower Bengal, sixty, and even ninety grains of quinine in twenty-four hours was no unusual dosage in malarial attacks, and I only saw the occurrence of hæmoglobinuria in one instance, which was one in which quinine was not being pushed.

Natives of an endemic area seem to acquire a relative immunity from hæmoglobinuric fever, which is not enjoyed by immigrants of the same race.

The teaching of Koch has led some to suspend the use of quinine on the occurrence of hæmoglobinuria; others regard it as an indication for increased doses. The treatment, however, which seems to have the most marked beneficial effect is the subcutaneous injection of large quantities of normal saline solution. This treatment is said to have resulted in the recovery of fifty-five consecutive cases so treated. Its effect is probably a mechanical one, that of clearing the renal tubuli blocked with hæmoglobin infarcts, and increasing the blood pressure (Gouzien, *XIII*^{E} *Congrès Internat. de Méd., Sous-section Méd. Coloniale,* p. 155).

Tuberculosis.

The Tubercle Bacillus—

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Definition.—Tuberculosis is a chronic infective disease caused by the tubercle bacillus.

Man and all domesticated animals may suffer from it. Wild animals, particularly the carnivora, are insusceptible. While this is so, it is probable that all animals may be infected by tuberculosis if placed in suitable environment and with suitable doses of the organism.

It has been stated that 7 per cent of mankind die from tuberculosis, and that from 30 to 50 per cent of cows in Britain are tuberculous.

Etiology.—In the causation of the disease one must bear in mind two factors, the soil and the germ. In the absorbing discussions which are taking place concerning the tubercle bacillus and its modes of entrance into the body, we are apt to give insufficient weight to the personal factor. It is now generally concluded that the bacillus is only capable of taking root in individuals whose nutrition and power of resistance are greatly lowered. In fact, tuberculosis may be looked on as the sequel of another debilitating condition due to accident or disease.

As, however, the tubercle bacillus bulks so largely in our consideration of the disease, we shall first consider it morphologically and biologically, returning later to the personal factor in the disease, when considering the portals of infection and channels of spread in the body and the relationships of human to bovine tuberculosis.

Historical.—1. Tuberculous lesions were first supposed to be evidences of a weak form of inflammation, occurring in a weak or scrofulous subject, no specific cause being assigned.

2. It was noticed that if the disease began at one spot, generalised tuberculosis might follow.

3. Niemeyer and Virchow considered that the formation of the tubercle nodule was not a specific process, but that caseation occurred because the inflammation was of a low degree; that the blood-supply was cut off by pressure of inflammatory products; that in the caseated material a ferment developed, and when the caseous material softened and broke into a blood-vessel, the ferment entered the blood and caused general tuberculosis.

4. Klencke in 1843 produced tuberculosis in rabbits by intravenous injection of tuberculous material, but the real significance of this was not recognised at the time, and by demonstrating the inoculability of tuberculosis in the lower animals, Villemin has the credit of being the first to show that the cause of the disease is a specific one. He took pieces of tuberculous material and successfully inoculated various animals, proving that the disease was infective (1865).

5. Koch and Baumgarten demonstrated microscopically the organism which causes the disease, and Koch succeeded, after many failures, in cultivating it on artificial medium. Koch's announcement of his discovery was made public on 24th March 1882. His demonstration of the relationship of the bacillus to the disease was so complete that the facts were at once accepted by scientists throughout the world. He laid down with the greatest precision that there was but one form of the tubercle bacillus; that *Perlsucht* in cattle, pulmonary tuberculosis in man, and tuberculosis in domestic animals, were all caused by one and the same micro-organism. Since the bacillus became available in pure culture, experiments on animals have more and more decisively demonstrated its infective nature, and somewhat modified Koch's first conclusions.

The proofs of the relationship of the bacillus to the disease may be stated as follows:—

1. The bacillus can be readily demonstrated in tuberculous lesions in man and in the lower animals.

2. It can be separated from such lesions and obtained in pure culture.

3. Inoculation of these pure cultures, and of subcultures from them, reproduces in susceptible animals the same disease, with macroscopic and microscopic lesions corresponding to those found in the natural disease.

4. From these experimental lesions the bacillus can be recovered in pure culture.

5. The chemical substances produced by the bacillus in cultivation and in the body are related.

THE TUBERCLE BACILLUS (*Bac. Tuberculosis*, Koch; Syn. *Mycobacterium Tuberculosis*).—The bacillus as ordinarily found in man is a short narrow rod of the length of one-quarter to one-half the diameter of a red blood corpuscle (1·5 to 3·5 μ). The breadth (*circ.* 0·2 μ) is pretty constant, provided the same method of staining be used. The ends are rounded or pointed. The rods are not as a rule absolutely straight; they are commonly slightly curved or bent at an angle; sometimes they are slightly sinuous or spiral, and occasionally adjacent rods lie at an obtuse angle with each other. Frequently there is an appearance of "beading," so that the rod presents deeply stained thicker parts with intervening clear spots. These were formerly supposed to be of the nature of spores, but it is more probable that they are not, one of the most cogent arguments against this interpretation being that the tubercle bacillus can be killed by a temperature far below that necessary to destroy spores. Some authorities suppose that the appearance may be an "artefact," produced in process of preparation of the microscopic film, but it occurs too constantly for this. Bulloch looks upon the clear spaces as degenerative in character.

It must be remembered that many competent observers consider that spores are present in certain stages of the life-history of the bacillus.

Occasionally the bacillus may fail to take the stain—for example, in some miliary lesions in the lung, lupus, and tuberculous disease of bone—but on inoculation of such tissue the disease may be reproduced.

The numbers of well-formed bacilli present in a lesion or discharge may, roughly speaking, be taken as evidence of the activity of the process.

The *bovine* bacillus is shorter than the human, seldom more than one-quarter the diameter of a human red blood corpuscle (2 μ) and averaging less. They are thick and straight. They stain evenly and deeply, and "beading" is usually absent. *Avian* tubercle bacilli are similar microscopically to the mammalian type, but present marked differences in culture and on experimental inoculation, so that many consider that they are of different species.

Staining Methods.—The methods of staining the tubercle bacillus depend on the difficulty with which it receives the stain, and the tenacity with which it holds the stain when it has entered.

Ehrlich has undoubtedly the credit for first pointing out these peculiar properties of the bacillus. It was found out at a very early stage that ordinary watery solutions of anilin dyes penetrated tubercle bacilli with extreme slowness and imperfectly. Ehrlich showed that by combining a basic anilin stain (gentian violet) with anilin water, its penetrating power was increased, and he also showed that when once stained the organism was able to resist the decolorising power of acids, even in strong solution, *e.g.* 33 per cent nitric acid or 25 per cent sulphuric acid, and even after exposure to these strengths for so long a period as a quarter of an hour. The stain now generally employed is *basic* fuchsin (rosanilin hydrochlorate).

The property of resistance to the decolorising action of acid, or "acid-fastness," was supposed by Ehrlich to be produced by some substance surrounding the bacillus, forming a covering permeable for anilin water, alkalies, carbolic acid, etc., but impermeable for acids. It is not possessed by very young cultures, as shown by Klein and later by Marmorek. Borrel, by protracted action of warm xylol on tubercle bacilli, extracted a substance resistant to acids and alcohol after treatment with stain. The tubercle bacilli had lost these qualities, but could still produce tubercles.

Unna and Klebs, de Schweinitz and Dorset, supposed that acid-fastness depended on the presence of fat in the bacillus, and there is no doubt that fatty acids, at any rate, are important constituents of the bacillus. Aronson (1898) has, however, shown that the body which gives the acid-fast character is of the nature of a wax, and this view has been confirmed by Bulloch and M'Leod.

These observers removed the substance by solvents of wax, and found that fat, fatty acids, and wax constituted 43·7 per cent by weight of the dried tubercle bacilli.

The changes which go on during the staining procedure may now be explained. When the fuchsin stained bacilli are immersed, for example, in sulphuric acid, the mono-acid rosanilin salts are converted into the soluble brownish tri-acid compounds which diffuse out of bacteria, which are not acid-fast. In the case of tubercle bacilli this change takes longer than in the case of other bacteria, not setting in, apparently, until some change in the permeability of the bacillus has been induced by the acid. The subsequent washing in water leads to a decomposition of the tri-acid compound with re-formation of mono-acid fuchsin, and the bacilli again appear red, as the fuchsin does not diffuse out (Bulloch).

A similar resistance is also manifested towards organic acids such as acetic, formic, oxalic, tartaric, lactic, and picric acids.

Recently other organisms, morphologically very similar to the tubercle bacillus, have been discovered which are also "acid-fast," and in some of these a distinction is made by their being less resistant to decolorisation by alcohol than the tubercle bacillus. In the case of others, however, *no known staining method differentiates from tubercle*, and diagnosis from biological characteristics must be had recourse to.

With a view to demonstrating the bacilli in sputum, for example, it is well to select that first expelled in the morning. Pour it out on a flat dish, and pick out any small yellow caseous points, or, failing these, the purulent looking parts. With a sterilised platinum loop place the selected material on an absolutely clean cover-glass (No. 1 thickness preferably), and smear in a thin layer over it, or better, superimpose another cover-glass, press gently so as to secure a thin film, and *slide* apart. It is well to place the cover-glass between clear filter paper before pressing, so that any excess of sputum soaks into the paper, which should be at once destroyed by burning.

For subsequent procedure refer to article on "POST-MORTEM METHODS," vol. ix. p. 488.

In the Pathological Department of the Royal Infirmary of Edinburgh, in the routine method of examining tuberculous sputum and discharges, the periods of exposure to alcohol and acid are one minute and two minutes respectively.

BIOLOGICAL CHARACTERS OF THE TUBERCLE BACILLUS.—As the bacilli of human, bovine, and avian tuberculosis in cultivation show certain fairly constant differences, which justify their classification as distinct varieties or races, they must be described separately; nevertheless, at a later stage data will be brought forward which indicate, contrary to Koch's rather arbitrary dictum, that there is a close relationship between these varieties—at least, between the two first, and that the apparent differences most probably depend on modifications of one original organism.

Human Bacillus.—On inspissated blood serum at a temperature of 35° to 37° C., the colonies appear from the tenth to the fourteenth day as discrete, dry, scaly growths, greyish in colour. These gradually extend and coalesce so as to form a thin wrinkled layer on the surface of the medium, reaching full development in six or seven weeks. In subcultures the growth tends to become more voluminous, and occasionally becomes brownish in colour in old cultures. The bacillus is non-motile. It is aerobic and faculatative anaerobic. While its optimum temperature for growth is 35° to 37° C. (98° to 101° F.), it can develop from 28° to 42° C. Its thermal death-point is about 70° C.

It is still doubtful whether it has a saprophytic stage of existence, and this question will be discussed later in considering the relationship of the tubercle bacillus to the streptothrices. Up to the present time it has been looked on as —in natural surroundings—strictly parasitic, developing only in the tissues of tuberculous animals.

It grows well on inspissated blood serum, and this medium is used in separating it in pure culture. Subcultures grow well on peptone agar to which 5 to 8 per cent of pure glycerine has been added, also on veal broth containing 5 per cent glycerine (Nocard and Roux), or on potato smeared with glycerine in sealed tubes (Powlowski), and even on other vegetables and vegetable infusions to which glycerine has been added. On these media, however, the bacillus rapidly loses its virulence.

Other media will be referred to when treating of the separation of the tubercle bacillus from lesions or fluids.

Adult cultures of the *Bovine* bacillus are somewhat similar to those of the human organism, though for several generations they are very thin and delicate, growing less luxuriantly than the human. They cannot as a rule be induced to develop on glycerine agar. On blood serum, cultures approximate in character very closely to those of the human bacillus.

Avian Tubercle Bacillus.—While the bacilli of avian tuberculosis correspond very closely to those of the mammalian type in their microscopic appearance and staining reactions, they differ considerably in culture and in results of experimental inoculation.

The growth on the surface of blood serum and glycerine agar is much more voluminous, forming soft, whitish, moist masses. The organism grows not only when glycerine is present, but on ordinary agar-agar and beef-broth. It will not grow upon potato. Development takes place at a temperature (43° C.) at which mammalian tubercle ceases to grow. On experimental inoculation, guinea-pigs usually resist infection, and intravenous injection even of large quantities of the avian bacilli in the case of dogs fails to produce any effect.

Nevertheless, Nocard has proved that mammalian bacilli may be modified so as to acquire all the characters of the avian bacilli, so that the apparent difference evidently depends on environment. Again, tuberculin prepared from avian bacilli has the same action as mammalian tuberculin.

Relation of the Tubercle Bacillus to Streptothrix Forms.—While the tubercle bacillus is of greatest importance in the form most commonly met with—that of the rodlet—later researches have shown, apparently on good grounds, that this form may be but an early form of an organism which develops into a more highly constituted filamentous fungus. Some authors have gone so far as to place its adult form in or near the streptothriceæ or actinomycetes.

Metschnikoff found the organism as short filaments in sputum and in the splenic pulp of tuberculous birds. Fischel and Bruns found similar forms, and Bruns considered them to be the saprophytic form of an organism whose parasitic form was a rodlet. Metschnikoff, in 1888, proposed to call the saprophytic form Sclerothrix Kochii.

Coppen Jones (1895) found similar appearances in sputum and in old cultures, and demonstrated dichotomous branching, and clubbing. In cultures the filaments were found on the surface of the growth. They contained certain deeply staining bodies, which possessed some of the properties of spores, and he considered that these were of the nature of chlamydospores.

Many observers have confirmed these observations. Babes and Levaditi found similar aberrant forms, in rabbits injected with cultures under the dura mater, at the end of four weeks.

Friedrich, Nösske, and Schültze concluded from experiments that such forms developed in lesions caused by injection of virulent cultures.

It must, however, be remembered that other bacteriologists, for example, Bostroem and Fischer, look upon clubbed forms as resulting from a degenerative change in the sheath, whilst others, Lubarsch and Schultz, look upon them as malformations from interrupted growth.

Abbot and Gildersleeve (1902) state that other acid-resisting bacilli also present these characteristics, and conclude that as these also produce on experimental inoculation nodular growths with many features in common with the lesions of tubercle and actinomyces, all these organisms ought to be classed together.

In the present state of our knowledge, as Bulloch remarks, "however seductive the theory may be that the tubercle bacillus, so called, is really a filamentous fungus with a relatively complicated structure, it is perhaps wiser to wait for more conclusive evidence, as the issues at stake are so vital for the doctrine of the origin and transmission of tuberculosis."

Nevertheless, sufficient evidence has been brought forward to emphasise the growing tendency to associate the tubercle bacillus with the streptothriceæ.

Diagnosis of the Tubercle Bacillus.—The difficulties in the way of diagnosing tubercle bacilli from other acid-fast organisms has already been indicated. Bacilli morphologically similar to those of tubercle are found in many non-tuberculous lesions in man. Though as a rule pseudo-tubercle bacilli are less resistant to acids and alcohol than the genuine organism, this is not true of all varieties.

A. Fraenkel stated in 1898 that he had repeatedly found acid-resisting bacilli in the sputum obtained from cases of non-tuberculous gangrene of the lung, and his observations have since been confirmed by Pappenheim and Lydia Rabinowitsch. Lubarsch (*B. M. J. Ep.* 14th June 1902) shows that these pseudo-tubercle bacilli may occur in a variety of conditions. In a case of gastric cancer, with pleural and pulmonary metastases and purulent bronchitis, accompanied by rapid emaciation, he found acid-resisting bacilli which were innocuous to guinea-pigs. He found similar bacilli in a bronchiectatic cavity; in an abscess near the hip-joint in a child one year old; in small cystic swellings, containing cheesy material, on the forearm of an adult who as a child had had tuberculosis. The swellings had the microscopic characters of sebaceous cysts. In the last case the explanation that the bacilli were dead or attenuated is not altogether outwith the realms of possibility. He concludes that the only reliable test is injection of suspected material into susceptible animals.

This does not solve the difficulty, however, as other observers have shown that acid-fast organisms—not tubercle—can produce experimental lesions identical with those of tubercle, so that we are thrown back again on cultural characters to control experimental results.

Möller observed the presence of acid-fast organisms in the mouth and sputum of non-tuberculous patients. Marzinowski found similar bacilli in the tonsil. Dietrich, in 1899, found acid-fast bacilli, resembling but distinct from those of tubercle in a suppurating cyst of the ovary which had ruptured into the intestine. The chief complication in the diagnosis of tuberculosis of the urinary tract in man is the presence of the *smegma bacillus* in the urine. This cannot be distinguished by its morphological characters alone from the tubercle bacillus. The tubercle bacillus is exceedingly pleomorphic, and may simulate the usually shorter and thicker smegma bacillus, and, on the contrary, the latter may occur as thin granular rods, indistinguishable from the typical organism of tuberculosis. As a rule, however, the smegma bacillus is not so resistant to decolorisation by alcohol as the tubercle bacillus, and so can be distinguished from it. It is harmless when inoculated into animals. The smegma bacillus was first discovered by Tavel and Alvarez, and fully described by Kruse.

Pappenheim recommends the following method of differentiating the tubercle bacillus from the smegma bacillus:—

1. Stain in the ordinary way with carbol-fuchsin.
2. Decolorise without washing in water, by immersing 3-5 times in a solution composed of absolute alcohol 100 parts, corallin 1, methylene blue to saturation, glycerine 20 parts.
3. Wash, dry, and mount in balsam.

The tubercle bacilli appear red, the smegma bacilli blue.

The bacillus of *Leprosy* is morphologically similar to that of tuberculosis, but it may be distinguished by being found in "lepra" cells, in the nodules in the disease, or lying in the sheaths of the nerves in the anæsthetic form. Moreover, they stain with ordinary aqueous aniline dyes, and at room temperature, whereas this fails with tubercle. When stained by Ziehl Neelsen's method they decolorise more readily.

G. van Houtum claims to have isolated the specific bacillus of leprosy (*Jl. of Path. and Bact.*, Sept. 1902).

Lustgarten's *Syphilis* bacillus also resembles the tubercle bacillus, but it still possesses a doubtful individuality, being possibly simply the smegma bacillus. In any case it has not been found in sufficient numbers, or with sufficient constancy in syphilitic lesions, to merit further attention here. The tubercle bacillus also stains by the complicated methods recommended by Lustgarten, and Baumgarten suggests that the few cases in which Lustgarten's bacillus has been found may be cases of mixed infection of tuberculosis and syphilis.

In certain domestic animals, and in foods derived from them, numerous acid-fast bacilli have been discovered. They are extremely common in milk. Many of these, however, can be decolorised with alcohol. Others, however, resemble tubercle bacilli in their properties and characters so closely that diagnosis is very difficult.

Acid-fast organisms, not tubercle bacilli, have been found by Murray Cowie in films made from scrapings from the udders and teats of healthy cows.

Similar organisms are frequently found in butter and cheese. The chief butter bacillus is one isolated by Petri and Rabinowitsch (*Mycobacterium butyri*). It is very like the tubercle bacillus, but now and then is thicker. In its protoplasm deeply coloured granules are sometimes visible, as in that bacillus. It grows at room temperature, and at incubator temperature there is visible growth after twenty-seven hours. Inoculation into guinea-pigs gives rise to nodular swellings resembling to some extent tuberculous infiltrations, but none of the animals inoculated reacted to tuberculin.

In this connection it has been reported that true tubercle bacilli, when mixed with melted butter and injected into the peritoneal cavity, do not produce a generalised tuberculosis, but simply a localised fibrous thickening of the peritoneum.

Korn claims to have isolated another bacillus from butter similar to tubercle, but differing in some respects from the Petri-Rabinowitsch bacillus.

Möller isolated acid-fast bacilli from cow-dung presenting certain characters distinguishing from tubercle bacilli and from other acid-fast organisms.

The same investigator created great interest by the announcement of the discovery on certain grasses of acid-fast bacilli closely resembling those of tubercle. One was isolated from timothy grass (*Phleum pratense*), and hence he named it the Timothy grass bacillus, or Grass bacillus I. It has since been found on other grasses, occurring widely in temperate climates. It resembles tubercle both in staining properties and in culture, and experimental inoculation gives rise to nodular swellings closely simulating those produced by tubercle.

He also isolated another bacillus from grasses, Grass bacillus II. (*Mycobact. graminis*), resembling both the tubercle bacillus and Grass bacillus I., but presenting certain differences. In culture it resembles rather that of avian tuberculosis, and the form of the bacillus in culture was extremely variable. Inoculation of animals led to fatal results, with changes closely resembling those found in experimental tuberculosis.

Möller considers that acid-fast bacilli found in butter and milk are probably simply varieties of the Grass bacillus.

Acid-fast bacilli have also been discovered in sewage.

Other acid-fast bacilli have been described; in fact, American authors lately tabulate nearly thirty of them, and some of them claim one after another of the characteristics formerly accredited solely to the tubercle bacillus, until one alone remains, viz. the tardy development of the tubercle bacillus in culture.

Instead of depending now as formerly on the tinctorial properties, one must now consider the origin of the material examined, and the history of the case from which suspected sputum or other fluid is taken. For example, in most cases of suspected pulmonary tuberculosis in man one can still give help, and sometimes even a definite diagnosis. The difficulty comes in when one has to examine urine, food-stuffs, or material which may contain tubercle bacilli, but the relationship of which to a possible infection from diseased man or animals cannot be proved.

Separation and Cultivation of the Tubercle Bacillus.—Koch, after failing with other media, succeeded in cultivating the bacilli on the surface of stiffened blood serum, and it is an evidence of the greatness and completeness of his work that his methods remain still, after twenty years, those most generally used for the separation of the tubercle bacillus and its cultivation outside the body of man.

To obtain cultures, a guinea-pig with early acute experimental tuberculosis is killed, portions of tuberculous tissue or glands are taken with aseptic precautions and implanted on the surface of solidified blood serum. The growth appears in ten to fourteen days as a dry scale, which gradually spreads over the surface, reaching full development in six or seven weeks. Some workers recommend that the piece of tissue should not at once be smeared over the surface of the serum, but kept for two or three weeks at 37°-38° C., and that after this time it should be broken up against the wall of the test-tube, and the juice from it smeared over the surface. In first cultures as a rule the growth is not plentiful, but it becomes more voluminous and luxuriant in subcultures.

Subcultures may be made on blood-serum or on glycerine agar, a medium which, curiously enough, cannot be used for separating the bacillus direct from lesions.

Glycerine beef-broth, glycerinated potato, *i.e.* slices of potato over which 5 per cent. solution of glycerine in water has been smeared, and other glycerinated media, have been used for continuing the subcultures.

Hesse (*Zeitsch. f. Hyg. und Infectionskrankh.* Bd. xxxi.) has recommended a medium containing a soluble albumin preparation known in commerce as "Nährstoff Heyden," made up as follows: Nährstoff Heyden, 5 gm.; common salt, 5 gm.; glycerine, 30 gm.; agar agar, 10 gm.; normal soda solution, 5 gm.; distilled water, 1000 c.c. This is at once seen to correspond to glycerine agar, with Nährstoff Heyden substituted for beef-broth. Menzi (*id.* Bd. xxxix.), Jochmann, and others, have also worked extensively with this medium, and come to the conclusion that it is a very good one for separating the bacillus, particularly from sputum. If tubercle bacilli are plentiful in the sediment from urine, they can also be readily separated. Microscopic growths are obtained in one to three days. It is, however, inferior to glycerine agar as a medium for subculturing the organism.

Kühne, Proskauer, and Beck found that luxuriant growths could be obtained in proteid free media. The two last have shown that the bacillus will grow in a medium consisting of magnesium citrate, ammonium sulphate, glycerine and mannite, or even in one containing only commercial ammonium carbonate, 0·35 per cent; acid potassium phosphate, 0·15 per cent; magnesium sulphate, 0·25 per cent; and glycerine, 1·5 per cent. The glycerine, however, cannot in any medium be replaced by bodies allied to it chemically.

De Schweinitz and Dorset, from chemical analyses of cultures, drew attention to the large amount of phosphoric acid present in the ash, and to the fact that this was the only acid present. They also stated that an acid reaction of the culture medium appeared to be favourable to the growth of the tubercle bacillus, and subsequently reported that addition of acid phosphate of potassium and the omission of sodium chloride gave a medium upon which development took place very rapidly (cp. Proskauer and Beck's medium). The medium they now used is composed as follows (*American Medicine*, 19th July 1902, p. 93):—"Chopped meat, one part; distilled water, two parts, heated at 45° to 60° C. for three hours, strained, boiled, filtered, and then 1 per cent. peptone and ½ per cent. acid potassium phosphate added. This solution is neutralised with sodium hydrate, boiled for one hour, 7 per cent glycerine added, and filtered; acidity equal to about 10 c.c. N/10 sodium hydrate required to neutralise 100 c.c. beef-broth, phenolphthalein being used as indicator." They report that this medium is eminently satisfactory, not only in securing a rapidity of growth, but also apparently in keeping up the virulence of the organism.

CHEMISTRY AND CHEMICAL PRODUCTS.—Little need be detailed here of the actual chemical composition of the tubercle bacillus. In addition to the fat, fatty acids, and wax already referred to, it contains a nucleic acid which is credited by Behring with possessing to a high degree the specific properties of Koch's tuberculin. The paper of de Schweinitz and Dorset, just referred to, may be consulted on this point.

It is much more important to consider the chemical substances produced by it to which the pathogenetic actions are due.

The most important of these are tuberculin and other bodies separated from crude tuberculin, some highly toxic, some believed to be directly curative.

Tuberculin was separated by R. Koch. It is prepared by growing the bacilli for six to eight weeks in a slightly alkaline veal-broth containing 1 per cent of peptone and 4 to 5 per cent of glycerine.

The whole is then evaporated to a tenth of its bulk on a water-bath, which kills the bacilli, and this fluid constitutes crude tuberculin. It contains 40 to 50 per cent. of glycerine, which prevents the growth of putrefactive organisms.

What would appear to be a specific action is shown by the fact that injection of it produces in tuberculous animals a considerable rise of temperature, whereas after injection into healthy animals the reaction is not so great. It was introduced by Koch as a curative agent, and accepted at the moment by the world as a "gift from the gods." Koch's theory of its action, founded upon experimental results in guinea-pigs, was that the tubercle bacillus secretes a substance having a necrotic action on the tissues, that when tuberculin is injected into a tuberculous patient, the proportion round a tuberculous focus becomes suddenly increased, great reaction takes place with necrosis and separation of the material containing dead and living tubercle bacilli. Virchow showed that from this very process its employment was attended with the greatest danger, as it led in many cases, by the freeing of bacilli formerly imprisoned in fibrous nodules, to dissemination of the disease. It is still used to produce this effect in cases of lupus, but the resulting ulcer takes long to heal up.

Tuberculin is chiefly used now in the diagnosis of the disease in cattle, only a small percentage of cases failing to react, and it is also used, chiefly on the Continent, with great precautions in the diagnosis of early tuberculosis in man. In this country, however, there is still a strong prejudice against its employment in men.

Hunter stated (*Brit. Med. Jour.* 1891) that tuberculin consists chiefly of (1) albumoses, (2) alkaloidal substances, (3) extractives, mucin, inorganic salts, etc. He prepared two modifications of tuberculin, one of which containing most of the albumoses produced less fever than the other.

Whether the albumoses found are the toxic bodies in tuberculin is doubtful. They may simply, according to Kühne, be carriers of the real toxine. This view he corroborated by growing the bacilli in a proteid free medium, and found that an albuminate produced had the same effect on animals as tuberculin.

Curative.—The opinion gained ground that the substance in tuberculin which causes the reaction resides in the fluid, whereas the supposed minimising and curative agent seems to reside in the bodies of the bacilli themselves. Koch's further researches were directed towards separating these, and attempting to employ the immunising substance in strengthening the tissues to resist the disease. These intracellular toxines seem to be very intimately bound up with the protoplasm, and to separate them he used the following procedures:—Young virulent cultures were dried *in vacuo*, and thoroughly rubbed up in an agate mortar, treated with sterilised distilled water, and centrifugalised for a long time. The clear fluid resulting was decanted, and formed Koch's "Tuberculin O." This was found to produce a reaction like the original tuberculin.

The deposit remaining was again dried and treated in a similar way, and the clear fluid decanted, the process being repeated until no deposit remained. All the fluids were then put together and formed Koch's "Tuberculin R" (T.R.) He stated that this contains only the substances present in the bacilli which are insoluble in glycerine. When this is injected into animals in small, repeated, and gradually increasing doses, he claims that it produces immunity against the original tuberculin, against Tuberculin O, and against living and virulent bacilli. He and others have applied it in man, and though they claim to have obtained success in treatment of tuberculosis in man, a great deal of healthy scepticism prevails, particularly in this country. Still the hope is gaining ground that in this direction a cure for tuberculosis may yet be obtained.

Working on similar lines, Klebs has introduced two extracts—*tuberculocidin* and *antiphthisin*. The former is made from tuberculin by removing so far as possible the substances which cause reaction. The latter is made from the fluid culture without the use of boiling heat to concentrate. This procedure, it is thought, preserves the immunising agent.

Von Ruck has also introduced two preparations.

The first, *tuberculinum purificatum*, is made from the culture fluid with the bacilli, by extraction *in vacuo* at 120°-130° F. for six weeks to two months, the object being to extract more of the bacterial proteids, and so to contain more of the immunising principles Koch found in Tuberculin R.

The second is a watery extract made at 120°-130° F. of dry tubercle bacilli freed from fat by action of sulphuric ether. Denison gives lengthy statistics which would go to prove that in therapeutic action these excel all other preparations.

TUBERCULIN AS A DIAGNOSTIC AGENT IN MAN.—Koch in 1890 expressed himself as follows:—"I believe I do not go too far when I assume that the medicament will in future be an indispensable aid to diagnosis. It will enable one to diagnose doubtful cases of incipient phthisis even when one fails to obtain certain knowledge of the nature of the disease by finding bacilli or elastic fibres in the sputum, or by physical examination."

At the London Congress on Tuberculosis, 1901, he detailed his method of using tuberculin, and his results so far.

After ascertaining that the temperature is not above normal for one, or better two days, he gives an injection of one-tenth to one milligram under the skin of the back in the forenoon, the amount given depending on the strength of the patient. If no reaction takes place double the dose is given on the third day, *i.e.* one full day intervening. If there is a slight rise of temperature—only a quarter of a degree centigrade, for example—the dose is not increased, but repeated as soon as the temperature has gone down to normal. It often happens that, though the same dose has been given, the second reaction is stronger than the first. This is quite specially characteristic, and may be regarded as an infallible sign of the presence of tuberculosis.

If the first small doses produce no reaction, he gives five, and, finally, even ten milligrams. He is accustomed to give this last quantity twice, and only when no reaction occurs under these conditions does he feel justified in assuming that the case is not one of fresh or progressive tuberculosis demanding specific treatment. By the end of 1900 he had personally observed 3000 cases. He expressly stated that he had in no case seen any untoward effect when the tuberculin was used in this way.

His paper was followed by a lively discussion. In general the use of tuberculin as a diagnostic agent was supported by all the continental and American members of congress. While some British physicians, *e.g.* M'Call Anderson and Eric France, spoke strongly in favour of it, others, notably Dr. C. Theodore Williams, condemned it. He thought that in initial cases without fever its employment is not advantageous, and considered it unreasonable, after all our efforts to build up the tissue and textures of the human body, to use a means for breaking them down. Dr. Edward Squire thought that the use of tuberculin even for diagnostic purposes was unjustifiable in tuberculosis of the lungs, though it was undoubtedly useful in surface or surgical tuberculosis.

The result of the discussion seemed to be the establishment of Koch's views, but nevertheless the agent is still far too dangerous to be employed as a routine means of diagnosis by practitioners.

Agglutination of the Tubercle Bacillus.—Koch has lately published a paper in the *Deutsche medicinische Wochenschrift,* November 28, 1901, in which he details the employment of this property of the bacillus in diagnosis. Arloing and Courmont, by using cultures on potato, in which the bacilli are fairly well separated from each other, obtained positive results as regards agglutination with the blood serum or serous exudation from tuberculous men and animals. Koch also obtained the reaction with ordinary cultures by special methods, but as it is obtained in other diseases as well, he concludes that a marked distinction cannot be drawn between the cases. He found, however, that by employment of small doses of tuberculin he could raise the agglutinating power, and concluded that this corresponds with the formation of an antitoxin, from the fact that the general condition of the patient showed improvement from the time that the agglutinating property appeared in the serum. He suggests this as a method of treatment in cases where no progress is being made under other methods. Others have also suggested the use of tuberculin therapeutically in alliance with other procedures, *e.g.* sanatorium treatment.

MORBID ANATOMY.—*Lesions produced by the Tubercle Bacillus.*—In order to understand the variation in the character of the lesions seen in man, we must premise variations both in the infective agent and in the soil on which it is implanted.

Thus the bacilli may vary in virulence, and the individual may vary in power of resistance.

Virulent bacilli may be expected to produce actively developing lesions, tending early to caseate and break down. Bacilli of slight virulence will rather produce chronic changes with tendency to formation of fibrous tissue enclosing the bacilli, and there is less liability to caseate and break down.

In children, in young adults, and in weaklings, the active form is more often met with. As age advances resistance becomes greater, and the lesions partake more of a chronic character. Hence, one must not expect —all things being apparently equal so far as the infective agent is concerned—to find exactly similar changes in all subjects.

Relation of the Bacilli to the Cells.—In man the bacilli, as a rule, may be said to be extra-cellular, *i.e.*, except as regards the giant cells. Sims

Woodhead points out, however, that in certain cases where recovery appears to be going on, bacilli may be found in epithelioid cells. He states that in animals the bacilli are found comparatively frequently in cells, particularly in the epithelial cells of the acini and small milk ducts of the tuberculous udders of cows. Benda has also noticed these appearances in the cells lining canals in other organs as well as in the lacteal ducts of udders, and looks on them as evidence of the spread of tuberculosis along the epithelial canals, a mode of spread which he considers very common, if not the most common.

Sims Woodhead further notes the interesting point that this accumulation of bacilli in the cells, particularly in those of the cat, has a peculiar significance from the fact that the tissues of that animal are exceedingly resistant to the attacks of tubercle bacilli, and only when this resistance is overcome by the invasion of large numbers of bacilli, does the animal succumb to the disease.

The "Grey" Tubercle.—The histological basis of all tuberculous lesions is the "grey" or "miliary" tubercle. This consists essentially of a cluster of large oval cells each of which possess a large and distinct nucleus and a considerable amount of protoplasm.

These cells—termed endothelioid or epithelioid—are derived by proliferation of the connective tissue cells of the part infected, and also by proliferation of endothelial cells of lymph channels, or capillaries near. Metschnikoff considers that they represent a form of white blood corpuscle, amœboid, and phagocytic, which have been attracted to the spot in virtue of positive chemotaxis, and are engaged in attacking the invading organisms. These epithelioid cells lie in the meshes of a stroma derived from the original connective tissue of the part. As one passes to the periphery of the grey tubercle, smaller cells—lymphocytes—are seen scattered among the endothelioid cells, and they become more numerous until at the edge of the nodule they form a more or less dense layer surrounding it. Frequently fibrin is found amongst the cells, particularly in lower animals.

These tubercles become non-vascular, and are then nourished by the fluids which transude from the blood-vessels, the vessels which formerly penetrated the area becoming blocked by endothelial proliferation or by thrombosis.

Such is the appearance of the rapidly forming acute miliary tubercle.

When development is less rapid, and also—according to Hamilton—when infection has taken place by way of lymphatics, *giant cells* are commonly seen.

These usually develop towards the centre of the tubercle, and surrounding them are arranged the endothelioid cells and lymphocytes. Some look on giant cells as evidence of degeneration, but many pathologists consider that they are active products of tissue reaction, and have defensive and perhaps reparative functions.

The giant cell of tubercle is large, rounded, or oval, with a crenated edge, from the prominences of which processes pass to join the supporting network or reticulum of the tubercle. It is multinucleated. The nuclei are flattened, with their long axes arranged radially, and are placed near the periphery of the cell, or clustered at one pole, this appearance to some extent depending on the plane of section. Occasionally the nuclei lie irregularly in the cell—for example, in small young giant cells. If bacilli are present they may be demonstrated near and between the nuclei.

The protoplasm takes ground stains better at the periphery than in the centre, indicating the presence of some necrotic action at the centre.

Origin of Giant Cells.—Giant cells may develop in several ways. 1. By excessive proliferation of a single endothelioid cell; the stimulus being so strong that the nuclei divide far more rapidly than the protoplasm, and tend to gravitate to the surface of the cell, seeking nutrition. This is the most generally accepted explanation.

2. By coalescence of a number of endothelioid cells, those in the centre becoming necrotic.

Occasionally appearances are met with which support this explanation, and there seems to be no reason why it should not hold good in some instances.

3. The appearance is due to the proliferation of the endothelial cells of a blocked capillary, belonging either to the lymphatic or blood vascular system.

4. Gaule and J. Arnold have shown that in tuberculous disease of organs containing epithelium, the epithelial cells begin to proliferate and may yield epithelioid and giant cells (Thoma).

The striking appearance of the grey tubercle containing the giant cell has led to this being looked on as characterising tuberculous formations, but as similar giant cells are met with in other chronic inflammatory changes, they must not be looked on as absolutely essential components of the miliary tubercle. Even when the various components of the tubercle are arranged in the characteristic manner described, one can look upon this picture as sufficient to stamp the disease as tubercle only, if, in addition, the presence of the typical tubercle bacillus is assured.

For example, experimental inoculation of "butter" bacilli in guinea-pigs produces similar morbid processes, differing only in the presence of polymorphonuclear leucocytes and fibrin, and the absence of giant cells, though lymphocytes and endothelial cells abound. Moeller's bacilli also produce a generalised condition in guinea-pigs, macroscopically and microscopically resembling ordinary tuberculosis.

Yellow or Caseating Tubercle.—Round the original "grey" tubercle others soon form, and all of these being non-vascular the central part of the enlarged nodule tends to undergo the peculiar necrotic change—caseation—so commonly met with in tuberculosis. In "caseation," or "cheesy transformation," death of the cells takes place comparatively slowly, so that in addition to coagulative necrosis there is time for some fatty degeneration to occur. This change converts the central part of the tubercle into a structureless, homogeneous, or finely granular material, in which none of the individual components can be distinguished. The cell breaks down, though particles of nuclear chromatin may long persist and still take hæmateïn or anilin stains. This is the yellow or caseating tubercle.

This morbid change may extend by formation of grey tubercles around until a large area of the tissue or organ becomes caseous. The caseous part tends usually to undergo liquefaction, producing a tuberculous "cold" abscess, or, in an organ such as the lung, bringing about excavation, the central softened material escaping by way of a bronchus.

It is believed (Prudden) that liquefaction presupposes a "mixed infection," the chemical products of the tubercle bacillus being able to cause caseation, whereas other organisms, such as micrococcus tetragenus, streptococcus, etc. are required to bring about the further change.

The destructive process does not by any means always take place. Frequently the diseased area becomes enclosed by formation of fibrous tissue walling it in, rendering it quiescent and innocuous. Under favourable circumstances the caseous area becomes dried up, and forms a soft whitish mass in the midst of pigmented scar tissue, or calcareous deposit may take place in it. In these collections fragments of tubercle bacilli may, with some difficulty, be demonstrated. In experimental tuberculosis in refractory animals the bacilli may become enclosed in concentric layers of a homogeneous substance in which calcareous deposit occurs. This drying up with fibrosis or calcification is nature's method of cure, and is frequently referred to as evidence of the curability of tuberculosis scars containing evidence of old tuberculosis being met with in from 20 to 50 per cent of all persons dying from other diseases.

Chronic Tuberculosis.—Acute lesions may become chronic from encapsulation by fibrous tissue, or lesions may be chronic from the outset. In cases where the bacilli are of moderate virulence, or where the individual attacked has great power of resistance, infection results in formation of connective tissue rather than in caseation. Giant cells are usually found, it being permissible to regard these as indicative of a degree of chronicity in tuberculosis as in other diseases, such as syphilis. Such changes develop very slowly, and after a time the central part may undergo very slow caseation.

Lesions of the various Organs and Tissues

Tuberculosis of the Lungs

Acute Miliary Tuberculosis.—This is the result usually of the breaking down of a primary focus in the lung, or in the bronchial or root glands, and escape of infective material containing virulent tubercle bacilli into the blood stream, in which they may be detected during life. The immediate result is that bacilli are fairly uniformly scattered through the lung, and produce grey tubercles in the walls of the vesicles. On section these are seen to have no special relation to bronchi or interlobular septa, but are scattered over the whole of the cut surface, and appear as well under the pleura. Frequently they tend to be aggregated at the apex. As a rule the patient dies before the tubercles can break down. In most cases the tuberculosis is generalised throughout the body, particularly in children, and the membranes of the brain, liver, spleen, and, to a less extent, the kidneys, contain numerous grey nodules. The pericardium and heart are rarely affected. Microscopically the tubercles show relationship to the circulation by their connection with blood-vessels, and in small vessels may form a projection in the intima. The latter appearance is not uncommon. Acute miliary tuberculosis can only arise when a tubercle involves and breaks through the wall of a still pervious vessel of some size. In about half of the cases the pulmonary vein is involved (Coats).

Lymphatic Miliary Tubercle.—The bacilli may also spread from a primary focus by way of lymphatics; and the nodules are then seen in clusters in the adventitia of the bronchi and vessels, and in lines along the septa. They are not so uniformly scattered as in the case of the vascular tuberculosis, and are very frequently localised in the neighbourhood of the primary focus. For example, a band of tubercles may extend into the lung from a tuberculous gland, or if the primary focus is in the lung they extend from that focus towards the root. Moreover, the tuberculosis is not generalised throughout the body. Bearing in mind these characters, it is not extremely difficult to distinguish between these two forms of miliary tuberculosis of the lungs.

Hamilton considers that the lymphatic tubercles invariably possess giant cells, and that these characterise it, but, on the contrary, their absence is by no means characteristic of vascular miliary tubercle.

Broncho-Pneumonic Tuberculosis.—Tuberculosis most frequently attacks the lungs by way of the air passages. Out of 257 cases of pulmonary tuberculosis in children investigated by the writer, 173 showed the broncho-pneumonic type, and in 26 others this type was combined with miliary tubercle, probably chiefly lymphatic in spread.

The condition commences as an inflammation of the smaller bronchi—bronchiolitis—which assumes a tuberculous character, or is of that nature from the outset. It may also be secondary to a lymphatic invasion of its walls, this producing a lesion which gradually spreads towards the lumen, causing a tuberculous bronchitis, or it may arise from the bursting of a caseous focus into the lumen of the bronchus.

In this form of the disease one must remember certain factors which have an important bearing on its origin and progress, in children particularly.

1. The smaller bronchioles possess no cartilage to strengthen their walls. They do possess, however, a complete encircling band of unstriped muscle, which is of great assistance to the short ciliated columnar epithelium lining their lumina in keeping them free and open. In inflammation this muscularis mucosæ becomes infiltrated with fluid and leucocytes, weakening it and interfering with its contractility.

2. Following certain diseases of childhood, *e.g.* measles and whooping-cough, bronchitis and other catarrhal conditions are apt to occur, and these may be looked upon as not improbably predisposing causes.

3. In bronchitis the epithelium tends to become detached in large pieces; and

4. As a result of paralysis of the muscularis referred to above, the cast-off cells and exudation remain *in situ.* When the condition spreads to the infundibular passages, as they do not possess ciliated epithelium or muscularis mucosa, the exudation cannot be expelled.

5. If this bronchiolitis be not, as it probably usually is, primarily tuberculous, we have, consequently, a suitable nidus for the implantation and development of the tubercle bacillus. Soon the manifestations dependent on its action appear. Caseation commences in the plug, and spreads to the walls of the bronchus. Meanwhile a marked inflammatory reaction is spreading from the wall of the bronchiole out along the septa between the vesicles and in the vesicles themselves. In the former proliferation of the cells and of the endothelium of the capillaries occurs, producing great thickening of the septa. The vesicles become packed with large catarrhal cells and leucocytes, with a varying amount of fibrin. As the condition progresses a coherent mass tends to form, attached to the wall of the vesicle nearest the centre of the nodule. As the walls are gradually becoming non-vascular the process of caseation gradually spreads outwards until a homogeneous, firm nodule has formed, in which, microscopically, the outline of bronchus and vesicles can with difficulty be made out.

The acute broncho-pneumonic nodules may possess no giant cells, but the later process spreading along the lymphatics (Hamilton) shows a giant-celled lesion.

In older children and in adults this caseated area tends to break down to form a cavity containing tuberculous pus and necrotic tissue, which becomes evacuated through the bronchus.

In *children* broncho-pneumonic nodules, all of recent date and varying in size up to a diameter of a quarter of an inch, may be scattered throughout the whole organ, the lung between being congested and vesicular. These nodules can readily be felt on passing the hand into the pleural cavity on opening the thorax. Those near the surface are roughly pyramidal in shape, with their base to the pleural surface. The nodules may be more numerous near the apex, but softening and excavation is not so commonly met with as in the adult.

Occasionally in children large areas of a lobe or the whole of a lobe become consolidated and caseous, presenting a more or less uniform greyish or yellowish colour. The term *caseous pneumonia* is sometimes applied to this condition.

In the *adult* the characters are different The disease usually firstly attacks the lung a short distance below the apex. This localisation near the apex is probably due to that being the least expansive part of the lung. The air stagnates, and tubercle bacilli are more likely to grow and develop in such circumstances (Coats). From the apex it extends downwards through the lung, so that the oldest lesions are to be found near the apex or in the lower lobes near their upper part, and the more recent farther down; the extreme base may be vesicular and healthy to the unaided eye.

The process, moreover, goes farther, so that softening of the caseated areas occurs, and the pus is discharged through the bronchi, forming the expectoration of pulmonary tuberculosis. This process results in "excavation" or "cavitation." The softened material tends to become disseminated throughout the bronchial tree, giving rise to fresh broncho-pneumonic nodules in the same lung; or later, may in a similar manner cause infection of the sound lung. In addition the process sets free bacilli, which spread along the lymphatics, so that lymphatic miliary tubercles frequently coexist along with the broncho-pneumonic. These can usually be distinguished by careful inspection.

Once more, lymphatic spread may predominate, but in such a case the primary lesion is usually less acute.

Briefly, the "picture" of a spreading broncho-pneumonic tuberculosis—the common pulmonary phthisis—is as follows:—

Extreme base—congested, vesicular, free from tubercles, or with a few small irregular clusters of grey tubercles, either early broncho-pneumonic or lymphatic.

Above this these have coalesced to form greyish masses, which in their centres are practically non-vascular.

Still higher they have become uniform, firm, non-vascular, yellow and caseating in the centre, grey at the periphery.

Higher still softening is beginning in the centre.

At the apex one or more recent cavities of varying size are seen, their walls irregular, rough, and lined with necrotic caseous material, the cavity communicating with a bronchus, the surface of which may be—usually is—congested and ulcerated. If the cavity be large ridges are seen on the walls, or bridges cross it, representing the more resistant septa, bronchi, or blood-vessels.

If the process take a favourable course a layer of vascular granulation tissue forms on the wall. The caseous material becomes cast off, and the irregularities smoothed down.

Later still the granulation tissue becomes fully developed to form fibrous tissue, and we now find a healed cavity with smooth, thin, fibrous walls. In course of time this tends to contract, and the walls to become dense and pigmented.

The *expectoration* in the early stages is composed of mucus with more or less numerous leucocytes, and large catarrhal epithelial cells with one or more nuclei. Later, these undergo fatty degeneration, and the sputum also contains elastic tissue. Bacilli are present in all stages.

Pleurisy.—Reaction also takes place in most cases in the *pleura* over extensively diseased areas of the lungs, and is usually simply an extension of the disease. The pleurisy may be fibrinous, sero-fibrinous, purulent, or hæmorrhagic. It may show grey tubercles or caseous points, most easily detected on the inter-lobar or diaphragmatic pleura, or these may not be evident to the naked eye, though demonstrable under the microscope. In chronic stages the pleura becomes greatly thickened and its layers adherent. It may occur without tuberculosis of the lung, spreading from the peritoneum or from a caseous mediastinal gland. Tuberculosis, in man, is rarely primary in the pleura.

CHRONIC PULMONARY TUBERCULOSIS.—The acute forms may become chronic, or the changes may be chronic from the outset. In the latter case the bacilli are less virulent, the dose is smaller, or perhaps, most important of all, the individual possesses greater resisting power.

The tuberculous process is always tending to heal by encapsulation with fibrous tissue. The outer layers of the tubercle become progressively fibrous, and the process consequently becomes quiescent. No special description of chronic phthisis or "fibroid phthisis," is necessary. The process is essentially the same as that described in the acute disease, but it is characterised by advance by way of the lymphatics into the septa, rather than by invasion of the vesicles. The cases are long protracted, and the process of the disease is slow. In the lung there is abundant cicatrization, so that the fibrous or fibroid changes are very evident, and may result in cure. The part of the lung affected is very firm, dense, pigmented. It usually contains small cavities with purulent contents, or at the centre of the mass a dry cheesy focus may be present. The interstitial tissue at the margins becomes greatly thickened and the vesicles contracted; their endothelium becomes cubical, so that in a well-marked case they present the appearance of narrow gland tubules. Giant cells are always to be seen at one part or other.

Round the fibroid contracted patches emphysema usually develops, and by the retraction of the thickened fibrous septa attached to the walls of bronchi these undergo irregular dilatation—bronchiectasis.

LARYNX, TRACHEA, AND BRONCHI.—Tuberculosis in larynx and trachea is rarely primary. It usually follows a destructive tuberculosis of the lungs, the sputum passing over the surface being the infective agent. In the case of the smaller bronchi the tubercles may extend along the wall in the lymphatics, develop into the yellow caseous tubercles, and break down into the lumen of the bronchus.

Wherever occurring, the final result is ulceration. The single ulcer is more or less rounded, and sometimes shows distinct tubercles at its edge. In the trachea the early ulcers may coalesce so as to produce a peculiar superficial worm-eaten appearance, which is somewhat characteristic. This appearance is not constant, and the ulcers may remain few in number, tending to extend at their edges, which are thickened, and also deeply into the wall, the general characters resembling those of tuberculous ulcers elsewhere.

In connection with the larynx tuberculosis usually begins below the epiglottis, differing from syphilitic ulceration, which usually starts on the upper surface or edges of the epiglottis, and works downwards into the larynx.

The most common situation of tuberculous ulcers of the larynx is at the posterior ends of the vocal cords, when they extend deeply at the bases of the arytenoid cartilages, their depth being great in proportion to their superficial area. The cartilages may be separated and destroyed. From this situation the ulceration may extend along the aryteno-epiglottic folds, or forwards and downwards in the larynx and trachea.

HEART AND PERICARDIUM.—The heart is rarely affected by tuberculosis.

It is most commonly met with in the form of caseous nodules in the heart muscle, the septum ventriculorum being frequently selected, or the outer wall of the ventricles. It accompanies tuberculosis elsewhere.

Tuberculosis of the endocardium is sometimes seen affecting the mural endocardium, but more frequently as a valvular condition with the usual features of an acute endocarditis. It is rare, however, judging from the experience of Edinburgh pathologists.

Tuberculosis of the pericardium is more common, but not so frequently met with in this country as American and German statistics would lead us to expect. Acute miliary tuberculosis may accompany a generalised tuberculosis, occurring in 7 cases out of 355 cases of tuberculosis examined in the Royal Hospital for Sick Children in Edinburgh. It may also extend from a softened mediastinal gland, or a tuberculous pleurisy or peritonitis. In older subjects it is characterised by great general or nodular thickening, by abundant fibrinous or hæmorrhagic exudation, beneath which small tubercles are seen.

It is remarkable, nevertheless, how often the pericardium escapes, even though surrounded by tuberculous disease of lungs, pleura, peritoneum, or glands.

When it does occur, and the patient survives long enough, the pericardium becomes greatly thickened and frequently adherent, encasing the heart in a dense thick fibrous capsule, in the deep layers of which caseous tubercles are evident.

Lymphatic Glands.—These glands are affected very commonly following the lungs as favourite points of attack by the tubercle bacillus.

Frequently no other lesion can be made out, and softened tuberculous glands frequently become the starting-point of a generalised tuberculosis.

The changes macroscopically and microscopically are similar to those seen elsewhere. The bacilli are caught in the sinuses, or brought thither enclosed in leucocytes. If active they set up reaction, producing the grey tubercle, so that the enlarged gland may show small grey points. These must be distinguished from the uniformly mottled appearance obtained in other conditions.

Part or the whole of the gland caseates and may break down, discharging its virulent contents on an epithelial or endothelial surface. The condition may retrogress at any stage, and heal by fibrosis, or if caseation has occurred the dead tissue may become encapsuled and invaded by fibrous tissue, and it may dry up and become the seat of calcareous deposit.

Tuberculosis of lymphatic glands is of supreme importance, from the point of view of origin and spread of the disease.

It may now be granted that the bacilli frequently enter the system by way of the tonsils and pharyngeal tonsillar structures, being carried inwards by leucocytes. They are frequently destroyed, but if the resistance is feeble they pass onwards and are caught in the glands. Similarly they may enter through decayed teeth, or through a moist catarrhal skin surface, and in none of these cases may there be any evident surface manifestation of tuberculosis.

They extend along the cervical chain of glands, sometimes missing one or a series, as they appear to be able to "jump" a gland, its sinuses probably being sufficiently wide to allow of their passage.

If the condition is not cured by surgical interference it may still extend downwards, and a caseous tuberculosis result in the bronchial and mediastinal glands from which the lungs may become affected, and an apparently primary respiratory tuberculosis be really the result of a tonsillar absorption from food. Benda and others disbelieve in tonsillar or cutaneous infections.

Bronchial and Root Glands.—In children the writer found that out of 183 cases where these glands were affected, in 123 the glands on the right side were more extensively affected than those on the left. Similar observations have been made independently by Dr. Batten (*Barth. Hosp. Rep.*, vol. xxxi.)

Again, a tuberculosis of bronchial glands may extend by way of anterior or posterior mediastinal glands—the latter more commonly—to the cœliac glands, and thence to the retroperitoneal and mesenteric glands. It may also progress in the opposite direction from mesenteric glands to bronchial.

Mesenteric Glands.—These are very commonly affected in children—far more commonly in this country than shown by any post-mortem statistics, because frequently a cure is brought about by suitable treatment, or even without treatment. Wherefore care must be taken not to base our ideas of the prevalence of abdominal tuberculosis upon post-mortem findings only.

The mesenteric glands are frequently found affected alone in children. In such a case the bacilli are supposed to be few in number, and insufficient to cause a local lesion in the intestine. They are supposed to be carried by leucocytes through Peyer's patches, and become blocked in the gland. As successive arrivals take place, by summation of their effect they are at last able to cause caseation.

If the bacilli are in greater numbers in the intestine they develop in and cause primarily an ulceration of Peyer's patches, then secondarily tuberculosis of the glands in connection with the affected patches.

While these lesions may occur from a primary ingestion tuberculosis, they more frequently follow destructive changes in the lungs, from which virulent sputum is swallowed.

Glands in connection with the extremities are seldom affected in man.

Alimentary Tract.—The lower part of the pharynx, the œsophagus, stomach, duodenum, and jejunum enjoy a comparative immunity from tuberculosis, and are usually affected only in advanced cases. There are many theories to account for this, such as the rapid passage of the contents of these parts, and the acidity of the gastric juice. In addition to these factors, however, one may suppose that the antiseptic power of the hydrochloric acid of the gastric juice and of the bile may have some effect in protecting the upper part of the tract, these influences being lost as the ileum is reached. Again, though decomposition of contents takes place normally in the large intestine only, in the presence of the lowered vitality of susceptible cases this may occur higher up in the ileum, and pave the way for infection by the tubercle bacillus. In addition the lymphoid Peyer's patches, like the similar structures in the pharynx—the tonsils and pharyngeal tonsils—tend to attract or separate out the bacilli.

The principal lesion found is the ulcer of the Peyer's patch, *i.e.*, in the lower part of the ileum, and chiefly in the lowest Peyer's patches.

Here, as in other tissues, the grey tubercle is the first manifestation of infection. Several develop in a Peyer's patch, grow, and coalesce. The resulting ulcer is necessarily irregular and its outline is sinuous. The whole Peyer's patch need not be affected. Spread is chiefly by the lymphatic vessels, and as these on the whole take the nearest way to their glands, *i.e.* round the lumen of the bowel towards the mesentery, the long axis of the ulcer tends to be transverse. In advanced cases the ulcer may encircle the bowel.

Seen from the peritoneal aspect the ulcers are recognised as dark areas, mottled with minute whitish spots or streaked with whitish lines corresponding to the tubercles which are spreading in the subserous lymphatics.

On opening the bowel the ulcer is seen to have raised irregular edges, the thickening gradually lessening towards the mucous membrane. The base is rough, showing caseous points, and in the ulcer and its edges tubercles may be detected.

Microscopically, all around the ulcer tubercles are seen in the submucous muscular and sub-serous coats. The last-named is practically always thickened, thus guarding against perforation.

In advanced cases the mesentery is thickened and shortened, and the glands contained are enlarged and caseous.

Frequently the surfaces of peritoneum become adherent, and the whole contents of the abdomen matted together. In the adhesions, caseous foci and glands are readily made out.

Occasionally only the lowest Peyer's patch and a line of glands leading upwards from the region of the ileocæcal valve are affected. In all cases the disease is commonly most advanced in this situation, and by fibrosis may lead to stricture of the bowel.

In adults, tuberculous strictures occur rarely in the small intestine, resembling closely, to the unaided eye, malignant growths.

The large intestine may show ulceration similar to that found in the ileum, but it may escape even in cases where the ileum is extensively diseased.

Fistula in ano is sometimes tuberculous in nature, and if so, resists attempts at cure.

Liver.—Tuberculosis of the liver is always secondary, and may be miliary or caseous, in both cases being usually accompanied by a generalised tuberculosis.

Small grey tubercles are most numerous immediately underneath the capsule; but though they are apparently not so numerous, to the naked eye, on the cut surface, when sections are examined microscopically, minute tubercles may be found in enormous numbers, in all stages of development. The liver presents one of the best opportunities for examining the microscopic structure of early tubercles. They are best seen near the portal spaces, apparently developing in connection with these. Some observers are of opinion that the epithelioid cells of the grey tubercle may develop from the liver cells themselves. Benda considers that spread occurs chiefly along the bile-ducts.

The yellow tubercle breaks down early, and whether caseous or forming an abscess, is always bile-stained like any other necrotic area in the liver.

Spleen.—Acute miliary tubercle and caseous tubercle are met with.

In the former case, occurring along with generalised miliary tuberculosis, the tubercles, which usually occur in the neighbourhood of arteries, may be distinguished from enlarged Malpighian bodies, which have a similar seat, by their projection on the freshly cut surface, the retraction of the splenic pulp pushing them upwards.

In caseous or chronic tubercle the cut surface is covered with large yellowish masses which may be softening at their centres. They are prominent, the splenic tissue retracting on section, and have to be distinguished from the nodules of lymphadenoma. This form occurs mostly in children in whom the abdominal glands are tuberculous (Coats).

Supra-Renals.—In Addison's disease the prevailing anatomical feature is enlargement and tuberculous caseation of the supra-renals.

Genito-Urinary Tuberculosis is usually associated with disease elsewhere.

Chronic tuberculosis of the *kidneys* is more common in males than females, and this fact has been taken by some observers (Weigert, Coats) to indicate that in most cases it originates in the testicle, or rather epididymis, and spreads thence upwards. Supposing that this were the case, one would expect that simultaneous affection of the kidneys would be common, whereas the disease is usually more advanced in one kidney, or may be confined to one.

Benda states that the disease starts in the duct-like structures in the kidney—the collecting tubules—and he has demonstrated bacilli in the cells of these parts.

Most pathologists consider that the bacilli are conducted to the kidneys in the blood stream, and that grey tubercles and then yellow caseous tubercles are formed in the usual way. In acute generalised miliary tuberculosis the kidney is usually less affected—to the naked eye—than spleen or liver.

In advanced cases, whichever be the manner in which the infective agent is brought, the result is the same. All stages of tuberculosis are seen, from the grey miliary tubercles to the softened caseous tubercle, discharging into the pelvis of the kidney. The process may go on until the whole kidney is converted into a multilocular cyst, lined by caseous material, the fibrous cyst wall showing little kidney substance. This condition is known as chronic tuberculosis of the kidney, renal phthisis, or scrofulous kidney. It is rare to find the perinephric tissue affected.

From the kidney substance the condition spreads by direct continuity to the pelvis and ureter. The accumulated caseous products may block the ureter at its lower end, so that the renal pelvis with the cavities opening into it, and the ureter become distended—hydronephrosis being super-added.

The wall of the ureter becomes greatly thickened, and lined by caseous material.

When the disease reaches the urinary bladder it spreads over the mucous membrane, and in time may reach the other ureter and extend up it by way of the lymphatics, contrary to peristalsis and current.

The mucous membrane of the pelvis of this kidney is first affected, and the disease possibly spreads up the collecting tubules, gradually extending outwards. One kidney with its ureter may, however, remain for long free from disease, and carries on the functions of both.

Extension may continue downwards, so that tubercles are found along the urethra, and even in the glans the writer has found early tubercles beneath the mucous membrane. It attacks prostate, producing caseous tubercles, extends to the seminal vesicles, and vasa deferentia, finally producing tuberculosis of the epididymis and testis.

Although Benda and his co-workers look upon primary tuberculosis of the epididymis as extremely rare, there seems no doubt that the disease may originate here, the bacilli being carried thither in the blood stream, and it may also commence in the vesiculæ seminales. From these situations it spreads upwards to bladder, ureters, and kidneys, in this case affecting the kidneys simultaneously or nearly so.

As a result of the destructive ulceration bacilli appear in the urine. They are usually shorter and thicker than the common varieties, and tend to lie in clumps. They usually stain uniformly.

Epididymis and Testis.—The disease in the majority of instances begins in the epididymis, and it usually becomes extensively caseous and softened before the testis is attacked, the tubercles in the latter radiating inwards from the mediastinum testis. In most cases inflammation of the tunica vaginalis co-exists. Rarely calcareous masses are met with in the epididymis which appear to represent old healed tuberculous foci.

Uterus and Appendages.—Tuberculous endometritis is rare. It follows advanced tuberculosis elsewhere. In this condition the lining membrane is pale, thickened, and succulent, showing microscopically the usual evidences of the nature of the disease.

Tuberculous salpingitis is less rare, and tubercles may spread through the wall to the serous surface.

Tuberculosis of the ovary in some cases affords the only evident origin of a tuberculous peritonitis.

Tuberculous Peritonitis.—Acute miliary tuberculosis of the peritoneum may be localised to the bases of tuberculous ulcers of the intestine, or may be generalised throughout the whole peritoneum.

Generalisation seldom takes place by perforation of an ulcer, but usually from softened caseous lymphatic glands, more especially those of the mesentery. Occasionally it follows disease of the vertebræ, and in some cases it extends from the vasa deferentia, vesiculæ seminales, or ovary, in these cases being usually localised.

Sometimes chronic fibroid tubercles occur over the whole or part of the surface as glistening flattened patches, which may be one-tenth of an inch or more in diameter. These may be the only visible manifestation of tuberculosis in the body, as in one case at least examined by the writer in which the tuberculosis was alimentary in origin, and the condition is possibly analogous to the "perlsucht" or "duckweed" type found in cattle.

The more acute form may result in an acute peritonitis with fibrinous exudation. There is considerable, sometimes great swelling of the abdomen. The inflammation may even become suppurative in character. More often, however, by the time the case comes to be examined post-mortem, the acute stage has passed off and evidence of chronic inflammation is found in the form of thickening of the peritoneum and generalised adhesions with matting of all the contents of the abdomen.

In these adhesions numerous caseous glands and areas are to be seen, and sometimes tuberculous abscesses in connection with ulcerations of the intestine.

The omentum is greatly thickened and shortened, forming a thick mass which can be felt from the surface of the abdomen. In it numerous tuberculous masses are to be seen.

TUBERCULOSIS OF BONES AND JOINTS

Bone.—Tuberculosis is the most common disease of bone, attacking by preference the young. In a large proportion of cases the joints are affected concurrently. The disease may be primary in the bone or in the synovial membrane, probably more frequently in the former.

Tuberculosis appears to be especially prone to attack young growing bone, an injury frequently predisposing. This has been proved experimentally. Schüller found that after injecting living tubercle bacilli into the blood he could induce tuberculosis of bone by inflicting injuries which would otherwise have been recovered from.

The disease begins under the periosteum; in the medulla near the epiphysea cartilage; in the epiphysis, or spreads to the epiphysis from the synovial membrane. The bacilli reach the parts nearly always by way of blood-vessels, seldom through the nutrient artery, more commonly through the articular arteries, whence it happens that the epiphyses are more frequently affected than the shaft. Additional evidence of this is shown by the frequent concurrence of synovial and osseous tuberculosis of joints, the same blood-vessels supplying both these parts.

The disease attacks spongy bone in preference to compact bone; thus the vertebral bodies, or the bones of the tarsus or carpus, and the articular ends of long bones, are more often affected than the shafts of long bones. In the case of the vertebræ, tuberculosis frequently affects simultaneously the adjacent surfaces of two bodies. In the phalanges it may affect the whole shaft (Strumous Dactylitis).

In tuberculosis of bone the microscopic appearances resemble those met with in the disease elsewhere. Primarily the soft medulla is affected, cellular grey tubercles forming in connection with the arterioles. These extend in the usual manner, and the central part caseates. The bony trabeculæ become absorbed, so that the spaces of the bone become larger.

Alexis Thomson, from his own and König's observations, distinguishes three varieties of tuberculosis of bone.

1. *Localised Chronic Tuberculosis.*—Here the lesions are comparatively small. They possess a translucent reddish-grey periphery, fairly well defined to the naked eye, with a greyish or more frequently yellowish caseous centre.

If extension is relatively rapid the caseous material contains gritty particles—the remains of thinned, incompletely absorbed, trabeculae; if slow, the bone is absorbed and an abscess forms.

Sometimes, however, the central part becomes densely infiltrated, and may become separated and lie as a sequestrum in a bath of pus, the cavity being lined with tuberculous granulation tissue. Whether or not this central sclerosis takes place, the granulation tissue may become organised into dense fibrous tissue, which later becomes the seat of osseous deposit.

The central part may cicatrise, and healing become complete, or it may remain soft and still contain active tubercle bacilli, which later may cause recrudescence of the disease. Even though bacilli be not demonstrable microscopically in such lesions, they may produce tuberculosis on inoculation into animals (Hamilton, M'Weeney).

2. *Tuberculous Necrosis.*—In this condition a visible sequestrum is produced which, as König pointed out, remains in connection with living bone. The bone containing it may show no alteration in external conformation. If the sequestrum is exposed on the surface of a joint, it becomes eburnated and polished. Probably the change is primarily due to tuberculous ostitis, which produces increased density and finally death. Surrounding the sequestrum grey granulations are seen in the medullary spaces.

3. *Diffuse progressive tuberculosis* is more common than the other two forms. The lesions in this form differ from those just described by the absence of a limiting wall. It is met with most typically in short bones. The spongy tissue becomes diffusely infiltrated with yellow caseous material, and this spreads by direct continuity from one bone to another, causing destruction of the bony framework—caries—often associated with suppuration.

This is the common lesion in strumous dactylitis, where the caseous material dilates the shaft, and also induces secondary thickening of the soft tissues around.

In short bones, and in the ends of long bones, caseation may not be evident, but rarefaction may be extreme from replacement of the marrow by vascular granulation tissue, with great increase in the number of round cells and osteoclasts. On maceration a very delicate framework of bone remains. Such altered bone may be readily cut with a knife.

Healing may take place. From the granulation tissue new bone may develop, replacing the diseased, and cause anchylosis. This healing is sometimes only apparent, and recrudescence may take place.

In the neighbourhood there are accompanying proliferative changes, resulting in new formation of bone, especially under the periosteum—"osteophytic" outgrowths.

Results of Spreading Tuberculosis of Bone.—It may penetrate to the surface and produce exfoliation of bone with formation of a cold abscess, *e.g.* in the lumbar spine or in the popliteal space.

If near epiphyseal cartilage, a gross lesion may completely destroy it. If small, the lesion destroys part only, or may extend through it. The epiphyseal cartilage may sclerose, becoming converted on the diaphyseal aspect into calcareous or bony tissue, so that its bone-forming function ends and the limb becomes stunted.

If near joint-cartilage, the granulation tissue may fungate through it, or may spread underneath it, separating the whole. The cartilage may become undermined from the edge, or it may become ulcerated, in all cases tuberculosis of the joint resulting. The invading and destructive power is greatly increased if septicity is superadded. It may give rise to general tuberculosis. Zahn of Geneva found this to occur in 3·2 per cent of his cases.

TUBERCULOSIS OF JOINTS.—Tuberculosis of joints is usually secondary to that of bone; it may be primary in the synovial membrane, or the epiphyseal ends of the bones and the synovial membrane may be simultaneously affected.

The disease is mostly one of children.

When secondary to bone, the disease may erode the cartilage and attack the joint directly, or it may extend in the first place to the synovial membrane at the margin of the cartilage.

Tuberculous Synovitis.—This presents three varieties. (1) *Miliary Tuberculosis.* This condition is described only in connection with the knee-joint. The membrane is not greatly thickened, but numerous grey tubercles can be detected especially round about the margins of the patella. The joint contains turbid synovial fluid, with or without flakes of lymph. Microscopically the tubercles are very cellular, and are arranged upon the blood-vessels. Alexis Thomson states that this form seems specially associated with previous genito-urinary tuberculosis.

(2) *Nodular Tuberculosis.*—In this form the synovial membrane is firm, and from it nodular cauliflower-like formations project. The turbid synovia contains frequently loose bodies, fibrinous or composed in part of cartilage or bone. These are derived from detached portions of the nodules or semi-lunar cartilages, or develop from the granulation tissue which forms in the synovial membrane.

(3) The most common form, however, is that known as "*gelatinous degeneration,*" "tumour albus" or white swelling, "strumous synovitis."

Here the synovial membrane becomes converted into vascular granulation tissue, pink, swollen, and pulpy, microscopically showing typical giant-cell systems, but rarely caseation. The exudation into the joint is serous, or sero-fibrinous. The altered synovial membrane after a time overlaps the edges of the cartilages, and aided by the changes already described in bone, which usually accompany it, it begins to eat away the cartilage. In time this becomes wholly destroyed, and the whole interior of the joint becomes lined with tuberculous granulation tissue, and is practically an abscess cavity. The disease then begins to extend to the surrounding tissues; the gelatinous degeneration attacks the ligaments, tendons, and tendon-sheaths. These become softened and disorganised, permitting of a pathological dislocation of the bones entering into the formation of the joint.

Abscesses may also form outside the joint, and the pus burrowing to the surface produces at length a fistulous opening communicating with the joint. The connecting sinus is lined with tuberculous granulation tissue which fungates at the surface around the opening in the skin.

Then if the bone has been attacked secondarily, tuberculous caries extends in it until a great part of the epiphysis has been destroyed. Meanwhile, as a concurrent result osteophytic outgrowths usually form on the shaft surface of the unaffected bone near.

TUBERCULOSIS OF BRAIN AND SPINAL CORD.—The disease generally occurs as a leptomeningitis. It occurs both in adults and children, but more commonly in the latter, the pia-arachnoid in children appearing to be specially prone to attack.

It may be a part of generalised tuberculosis, and, in this case, the primary focus is usually to be found in a softening lymph gland, either thoracic or abdominal, or it may be the only secondary manifestation present, following destructive tuberculosis of the lungs. In most cases, however, careful examination, microscopic if necessary, will disclose some evidence of the disease in other organs. It also follows distant disease of bones or of the generative organs.

Lastly, it may occur by direct extension from tuberculous disease of the bones forming the cranial cavity, more particularly disease of the temporal bone.

The writer found that out of 96 cases—all under 12 years—in which it could be approximately determined, the primary focus was in the bronchial glands in 60 cases (62·5 per cent), in the lungs in 15 cases (15·6 per cent), and in the remaining 21 cases (21·9 per cent) it was apparently abdominal.

In 8 of the 96 cases the child was under one year of age.

In 11 cases of tuberculous meningitis caries of the middle ear existed, and in 6 of these no other causative focus could be found.

In a typical case of cerebral meningitis in a child, on removing the calvarium and dura mater the convolutions are found to be flattened, and the sulci narrow. The surface of the arachnoid is dry, glistening, and sticky, and may be pale, or more often congested. A few grey or yellow tubercles may be detected along the Rolandic fissure, but rarely elsewhere on the vertex. The Pacchionian bodies in children may be mistaken for tubercles.

If one then proceed to remove the brain in the usual manner (see Post Mortem Methods, vol. ix. p. 478) a large excess of serous fluid, turbid in appearance, escapes, this excess being a very common characteristic.

On examining the base, the structures from the chiasma backwards are veiled by recent deposit of tough, gelatinous lymph, usually greenish in colour, in the sub-arachnoid space. Similar deposit occurs on the tips of the temporal lobes, and over the anterior part of the superior vermiform lobe of the cerebellum.

When this deposit is at all thick the tubercles cannot be distinguished, but one can almost always detect them by separating the lips of the Sylvian fissure which are glued together, and examining the vessels there, using a magnifying glass if necessary. If they cannot be demonstrated even here, they can usually be made out distinctly on the upper surface of the cerebellum.

The grey tubercles occur as small whitish spots on the line of the small vessels, interrupting their continuity. When these are examined under the microscope, the condition appears as a cellular infiltration and thickening of the adventitia, giant cells being very seldom found, or the nodule may have extended more in the vessel wall, causing occlusion of it, and showing some necrosis in its centre.

In an ordinary typical case the tubercles are found closely aggregated in the Sylvian fissure, and spreading thence on to the surfaces in the neighbourhood. They also may extend up along the Rolandic area, diminishing in numbers as they go. They are also readily seen, but scattered, on the under surface of the frontal lobe and over the anterior part of the temporal convolutions. On the under surface of the cerebellum they are visible, but not so distinctly as on the upper surface extending outwards from the vermiform lobe. Adhesions, usually recent, exist, as a rule, in the longitudinal fissure. Grey tubercles may be seen in these, and also extending along the inner surface of the cerebral hemispheres close to the corpus callosum.

Entering the interior they may be detected in the choroid plexus, velum interpositum, and sometimes even on the ependyma. This usually is granular. The ventricles, chiefly the lateral, are dilated, and contain excess of turbid fluid, this excess being partly due to the inflammatory condition of ependyma and choroid and probably also in part to a degree of obstruction to the drainage of the ventricles produced by the thickened velum. The foramen of Majendie is never blocked as in posterior basic meningitis.

The appearance of the brain itself is also altered. Under the ependyma the white matter is softened, sometimes almost pulpy, and the corpus callosum tears very readily. It is difficult to explain this morbid change. It is probably not a "white softening" so called, as no special signs of it exist during life. Some suppose that the inflamed ependyma allows the ventricular fluid to permeate the brain substance, and produce a condition resembling maceration. If it were due to the spread of tubercle nodules along the vessels, one should expect it to be specially evident in the cortex, where such spread takes place.

Yellow softening has been described as occurring in the area of cortex supplied by the middle cerebral artery (Barlow).

Localised Miliary Tuberculosis.—While this does occur in children, it is more common in adults than the generalised condition, which is commoner in children.

So far as the writer can determine from his own experience, such tubercles are usually yellower, larger, flat, and sometimes confluent. The patches occur on the vertex, often along the Rolandic area, and though the condition, as seen post-mortem, seems slight, it is nevertheless, often rapidly fatal.

In tuberculous meningitis the disease may spread to the choroid—affording a physical sign of use in the later stages.

Occasionally one meets with fibrous areas on the convexity containing small caseous deposits, which would indicate that recovery may take place from this localised form. The generalised form may, to all intents and purposes, be looked on as invariably fatal.

The frequency of the occurrence of tuberculous meningitis in children may be inferred from statistics prepared by the writer from the post-mortem records in the Edinburgh Sick Children's Hospital. Out of 331 cases of tuberculosis, the central nervous system was involved in 158 cases; acute tuberculous meningitis occurred alone in 121 cases; acute tuberculous meningitis with caseous nodules in 26 cases; and caseous nodules alone in 11 cases. In the greater number of the second class the caseous nodules proved the centre of dissemination of the meningitis. Still found caseous nodules in 15 per cent of his cases.

Caseous tuberculous nodules varying in size up to that of a walnut occur in the substance of brain or cerebellum, or develop from the matres and grow downwards into the brain. The former appear to have no special proclivity for cerebrum or cerebellum. They also develop in the basal ganglia and, rarely, even in the choroid plexus. Surrounding them smaller tubercles are usually found, and they may give rise to an acute meningitis, usually localised to their neighbourhood, but sometimes general.

Spinal Cord.—The spinal meninges are usually found affected along with the cerebral, and secondary to them. Occasionally, however, they are free, as for example, in 9 out of 35 cases examined at the Edinburgh Sick Children's Hospital. Occasionally the disease commences in the spinal cord, as for example, by extension from a vertebral caries or from other localised tuberculosis near. This appeared to be the case in 4 out of the above mentioned 35 cases.

Very frequently the naked-eye appearances are not so marked as in the brain, the surface being simply congested and granular, with delicate adhesions to the dura, but the tubercles may be well marked.

The condition varies in intensity in the different regions of the cord. It is frequently confined to the cervical cord. It may affect the cervical and lumbar cord, missing the dorsal, or it may affect the lumbar cord only, or it may be evident in the cervical region, and gradually become less so as one passes downwards.

Early Tuberculosis of the Dura Mater.—Occasionally a few flattened soft granulations are found on the dura. The writer recollects only three of such cases. They are never of large size.

SKIN.—Lupus is the commonest form of tuberculosis of the skin. In this case lymphoid cells collect in masses round the vascular network in the corium, and in the meshes epithelioid and giant cells may be found. The giant cells differ somewhat from those found elsewhere, in not possessing distinct processes. Tubercle bacilli are present, but in such scanty proportion that they are hard to detect.

The sebaceous glands and hair follicles are destroyed, but it is said (Coats) that the sweat glands are spared. The condition undergoes degeneration and ulceration, or may cicatrise without ulceration. It may be unaccompanied by tuberculous manifestation elsewhere.

LESIONS OF TUBERCULOSIS IN ANIMALS

On the whole, appearances similar to those found in man prevail. There are, however, certain minor variations in structure in certain animals, and bacilli are more readily demonstrated than in the tissues of man.

In *cattle*, tuberculosis is very common. The structures most frequently affected are glands and serous membranes, particularly the pleura and peritoneum, and the lungs.

In the serous membranes the tubercles form masses frequently of some size, which may form villous projections from the surface. These nodules have been compared to pearls, whence the terms "Pearl disease" or Perlsucht. When they are in the form of flattened fibrous tubercles they are compared to duckweed, and have been given the name Meerlinsigkeit. In internal organs, comparatively large rounded nodules and sometimes considerable infiltrations are met with.

These nodules are peculiarly prone to calcification.

Tuberculosis in *horses* somewhat resembles that in cattle. Occasionally large cellular masses are formed which have been mistaken for sarcoma.

In *swine* tuberculosis occurs frequently. It resembles in its general characters bovine tuberculosis. Invasion often takes place by way of the tonsils, as shown by Sidney Martin.

The disease is very common in *monkeys.* It usually begins in the lungs, but is apt to extend to other organs as a chronic general tuberculosis, so as to form comparatively large foci, which usually break down and produce cavities.

Tuberculosis of *fowls* is produced by a bacillus probably related to that of mammalian tuberculosis, but varying to some degree in morphological and biological characters. These differences most probably depend on environment. Nocard, Fischel, and Mafucci succeeded in bringing about approximation in external qualities.

PORTALS OF INVASION AND CHANNELS OF SPREAD IN MAN

The tubercle bacillus may invade the body by way of the respiratory passages, the alimentary tract, the skin, and more rarely by the generative organs during intercourse.

The first of these, the *respiratory invasion*, is by far the most common, both in adults and children. Even before Koch read his remarkable paper at the London Congress in 1901, this opinion was generally held. He considers that entrance is obtained so seldom by other passages and surfaces as to be a negligeable quantity. It is a question, however, whether this dictum holds good so far as children are concerned, or at least, so far as this country is concerned, for statistics carefully compiled from the records of some of the more important British Hospitals for Sick Children would lead us to conclude that ingestion tuberculosis is still important, though much less important than formerly was thought.

In considering the chances of exposure to infection by this method of transmission it is necessary to remember that—(1) The tubercle bacillus is not an ubiquitous organism; it does not occur diffused throughout the whole atmosphere, but only in the neighbourhood of cases of the disease.

2. The bacillus dies when exposed to fresh air and sunshine, whether direct or diffused.

3. The chief danger is from sputum from cases of phthisis. If every consumptive could be taught to destroy his expectoration the incidence of the disease would sink to insignificant proportions.

4. In ordinary quiet respiration the expired air is sterile. In forced expiration, *e.g.* coughing, a fine spray of moist particles containing many bacilli in the case of a consumptive is projected, and this being inhaled by another person, may produce the disease. Koch considers this point of special importance.

5. Sputum is dangerous if allowed to dry and become mixed with dust. When this is raised by currents of air or conveyed to the mouth by the hands, as in the case of creeping infants, it causes tuberculosis in a susceptible person. If such dust is protected from the sunlight it retains its virulence for years.

In respiratory tuberculosis the bacilli gain admission by any part of the respiratory tract—nasal passages and naso-pharynx, larynx, trachea, and bronchial tree. The larynx rarely shows primary infection; this being most common below that level. In some cases the organism seems able to pass through the bronchial mucous membrane without producing a local lesion, and to infect the lymphatic glands.

From the naso-pharynx infection of the middle ear may take place by way of the Eustachian tube.

Alimentary Tract.—The bacilli are able to gain entrance through any part of this tract except pharynx, œsophagus, stomach and duodenum. The parts most commonly invaded are the lower part of the ileum and the tonsils. Bacilli have been demonstrated entering the latter.

From Sidney Martin's experiments one concludes that the tonsils are chiefly attacked by bacilli in articles of food. In his inhalation experiments he could not get invasion of the tonsil. There may be no local lesion either in intestine or tonsil, but the glands in connection with these are affected, and from these the disease spreads. Even though some authorities, *e.g.* Benda, will not admit a primary tonsillar infection, the evidence obtained from post-mortems in children and experience of cases in which removal of scrofulous cervical glands—the only manifestation of tuberculosis in the body—cure the patient completely, compel us to believe that infection certainly can take place by way of the tonsils. The intestine is much more often affected, however, either primarily or secondarily to a destructive pulmonary tuberculosis. The bacilli enter through the Peyer's patches or are carried in through these by leucocytes.

To determine the relative frequency of respiratory and ingestion tuberculosis in children, the writer in 1899 investigated the post-mortem records of the Royal Edinburgh Hospital for Sick Children, and found that out of 331 cases in which the primary focus could approximately be determined, 221 or 67 per cent were of respiratory origin, and 93 or 28·1 per cent were the result of ingestion. Two years later, in the light of Koch's paper, he examined the additional records, and found that during this period 43 cases of tuberculosis were sectioed, of which 11 or 25·6 per cent were alimentary in origin. We have thus a total of 374 cases of which 104 or 27·8 per cent were, so far as could be determined, alimentary in origin.

Dr. Geo. Still found, at Great Ormonde Street, London, that in 63·8 per cent of his cases infection had probably taken place through the respiratory tract; in 29·1 per cent the alimentary tract had been primarily affected.

Dr. Carr, out of 120 autopsies on tuberculous children at the Chelsea Children's Hospital, found that 16·7 per cent showed evidence of primary abdominal infection.

Dr. Guthrie, at Paddington Green Children's Hospital, found in a series of 77 cases that 19 of these or 26 per cent had been infected through the intestine. Kossel found in 14 cases of tuberculosis in children, varying in age from one and a half to ten years, that the primary focus in 4 cases was in the mesenteric glands. There was no symptom of this during life. Heller and Hueppe give similar evidence.

These figures, which receive additional value from the approximate results arrived at by widely separated and independent observers, afford a strong ground on which to rest in refusing to accept Koch's dictum that tuberculosis is practically never ingestive in origin.

Even allowing a wide margin for error, we must remember that, after all, these are percentages of *deaths* from tuberculosis and do not indicate the frequency of abdominal tuberculosis in childhood during life. Many cases of abdominal tuberculosis recover; some cannot be diagnosed with certainty during life, and these with kindred cases must necessarily bring up the percentage of cases of ingestion tuberculosis.

In this country, therefore, we cannot accept statistics from other countries as applicable to our own circumstances.

So long as our population prefers to drink its milk raw this danger will remain, and individuals who are susceptible will be exposed to the dangers of infection through the alimentary tract.

The bacilli may invade the *skin*, either producing a local tuberculosis—lupus or scrofuloderma—or passing on and attacking the glands.

Frequently, as for example in tuberculosis of bones and joints, or of epididymis, one cannot detect the point of invasion.

Again, even in well-marked thoracic or abdominal tuberculosis it is impossible to tell the point of invasion. In an apparently undoubted respiratory tuberculosis the bacilli may have entered through some part of the alimentary tract, and by circuitous routes arrived at the bronchial glands or lungs, setting up tuberculosis there. The reverse may also take place, so that the figures in statistics of primary respiratory, or alimentary tuberculosis must be looked on as approximate only.

CHANNELS OF SPREAD IN THE BODY.—1. *Along Epithelial Canals and Surfaces.*—This is one of the most important means of spread, particularly in the air-passages and alimentary system. It explains why pulmonary tuberculosis is such a progressive and fatal disease.

In the lungs it generally begins at one focus or group of foci. These break down, and bacilli and softened caseous material are discharged into bronchi. During breathing and coughing this gets into other bronchi, setting up secondary foci. Caseation is usually a characteristic of tuberculosis which spreads by way of the bronchi. Liberated bacilli may be carried to the trachea and lodge in the larynx, or may even be carried to and infect the tongue. They may be swallowed and affect the mucous membrane of small or large intestine, the sputum passing through the stomach undestroyed. A similar spread occurs in genito-urinary system as already described.

2. *Lymphatics.*—Nodules may spread along the lymphatic vessels and spaces in lungs, nerves, cerebral membranes, intestine. A tuberculous peritonitis may spread through the lymphatic spaces of the diaphragm to pleura and thence to lung.

In the lung a tuberculosis spreading along lymphatics tends to cause fibrous formation with giant cells.

Tubercle may attack the thoracic duct.

3. *Blood-vessels.*—Spread takes place chiefly by way of veins as demonstrated by Weigert, though Ponfick has shown that the walls of arteries may be invaded in exactly the same way.

If a tuberculous focus ruptures into the lumen of a vein the organisms are carried to the lungs, setting up tuberculosis there. They may pass through the lungs and set up a general tuberculosis. Tubercle nodules are constantly forming in the walls of capillaries and veins. Generally they become sealed up by thrombosis or by proliferation of the endothelial cells, so that dissemination does not take place. General tuberculosis can only occur when a focus breaks into a still pervious vessel.

Mixed Infection in Tuberculosis

It has for some time been urged that the tubercle bacillus is not able of itself to produce all the lesions met with in the disease called tuberculosis.

The late Professor Kanthack wrote very strongly against the idea that each infectious disease depended on one specific germ, and that all other organisms found in the tissues were unimportant so far as the etiology of the disease was concerned.

He believed that most of the manifestations of these diseases, for example—pneumonia, cholera, etc., are due to a mixed infection; the special organism requiring the assistance of others accompanying it to pave the way or produce a suitable nidus for its development.

In tuberculosis, as in these diseases, the doctrine of mixed infection has strong support.

Prudden showed that excavation following experimental infection became much more active if pyogenic organisms gained entrance to the tuberculous tissues.

A. G. Foulerton and Prof. W. Ophüls read papers on this subject at the British Congress of Tuberculosis (1901), and from these the following abstract is made. Foulerton's paper dealt specially with mixed infections in pulmonary tuberculosis.

"While there can be no question as to the cardinal part which *bacillus tuberculosis* plays as the primary, or original, factor in the condition known as chronic pulmonary phthisis, the influence of the specific parasite in the production of the symptoms characteristic of this condition, and its importance as an ultimate factor in the excessive mortality caused by the disease, are not by any means so well established.

Frequently, indeed almost invariably, the terms chronic pulmonary tuberculosis and chronic pulmonary phthisis are used in clinical medicine as if synonymous; whereas, pathologically, the two conditions differ widely, although agreeing in the fact that *bacillus tuberculosis* is present in the lesions of each. In uncomplicated chronic pulmonary tuberculosis the single organism present, the specific bacillus, is one which, under the given conditions, does not manifest more than a quite low degree of virulence in the majority of cases, whether as regards its direct action on the tissues actually infected, or as regards its action on the system as a whole by the production of toxine. In chronic pulmonary phthisis, on the other hand, to the action of this parasite is added the more acute influence of pyogenic organisms, whose potentiality for evil—again under the given conditions—is incomparably greater, whether by direct action on the tissues infected or by the production of toxines.

Chronic pulmonary tuberculosis is rarely recognised by the physician in his practice, because of the absence of any definite symptoms produced by it in the majority of instances, such cases as are diagnosed being usually those in which a certain amount of cough has attracted attention to the chest, and the sputum has, in consequence, been examined. On the other hand, such a condition of uncomplicated pulmonary tuberculosis, as being the initial stage of chronic pulmonary phthisis, must, we know, be an extremely common one, and the frequency of its occurrence is emphasised when we consider, not only the number of cases in which secondary infections have determined the onset of definite pulmonary phthisis, but also the large number of cases of pulmonary tuberculosis which, there is reason to believe, never arrive at that stage, and are not recognised at any time during life. The frequency of these latter cases can only be estimated from the number of instances in which lesions, usually of limited extent, indicative of cured or arrested tuberculous infection, are found in the lungs of adults dying from other causes.

Our knowledge of the bacteria met with in tuberculous cavities has been arrived at by the examination of the sputum during life, and of the walls and contents of the cavities after death.

Practically all who have worked at the subject are agreed that various species of cocci are the predominating organisms found, especially *Streptococcus pyogenes, Staphylococcus pyogenes aureus, Staphylococcus pyogenes albus, Diplococcus pneumoniæ,* and *Micrococcus tetragenus.* The first of these is the most important. Their local effects are manifest in an active destruction of the tissues actually infected, by the occurrence of perinodular pneumonia and by what may be described in general terms as a lowering of the powers of resistance—a lowering of the vitality of the tissues in the neighbourhood of those actually infected; the latter effect being partly due to the direct action of toxines produced by the bacteria, and partly to vascular disturbance in the proximity of the lesions.

Their action on the system at large may be expressed either by the results following on the absorption of the toxines (toxæmia), or those of an actual infection of the blood generally by the bacteria themselves. The latter may be excluded as an important factor save only as a terminal infection.

It is of some interest to note that the bacteria which are under normal conditions arrested in the fore part of the nasal passages are amongst those which are most frequently found infecting pulmonary cavities, *e.g., diplococcus pneumoniæ, staphylococcus pyogenes aureus, streptococcus pyogenes,* and *bacillus pneumoniæ* (Friedländer).

We have good reason for believing that the tubercle bacillus by itself would not, at all events in a chronic infection, produce all the pathological features of fully developed chronic pulmonary phthisis during life, but we must allow that infection of a cavity by, for example, streptococcus pyogenes, will afford a satisfactory explanation of phenomena such as evidences of active destruction, and of hectic fever with its accompanying evening temperature, morbid sweating, and general wasting. The tubercle bacillus in pure infection never produces active destruction of tissues, it of course produces granulomata which tend slowly to break down as a result of interference with their blood supply, but their very presence is evidence of a low grade of virulence in the organism which produces them. A quite similar result may be produced by a purely mechanical irritation.

As to toxæmia, all one can say is that in all forms of chronic pure tuberculosis in parts other than the lungs, the symptoms referable to a toxæmia are either of the slightest or conspicuously absent; but given a breaking down of tubercles in the lung substance, with secondary infection of the cavities or an ulceration of tuberculous lesions in the intestine, and one finds the symptoms of toxæmia well-marked. As a result of such observations it has been suggested that the treatment of the secondary infections should be the chief object aimed at.

The comparative failure of methods of treatment by tuberculin is probably almost entirely due to the ignoring of the effects of such secondary infections by pyogenic cocci.

It is well known that by keeping phthisical patients in an atmosphere practically free from germs, such as may be attained at a high altitude, and by enforcing as complete rest as possible, they are protected against reinfection by pyogenic cocci, and placed in a condition in which the intensity of the present pyogenic infection may be reduced.

Ophüls considers that some of the acute exacerbations, which usually assume the form of pneumonic processes, are produced by the tubercle bacillus alone, whereas others are produced by the mixed infections. He chiefly examined sections from the walls of cavities and parts of the lung affected.

The opinions here expressed, though received in their entirety with caution, are supported by the experiments of Délèpine and Ravenel, who found that injection of mixed human sputa could cause the disease in lower animals which resist infection by pure growths of human tubercle bacilli.

Pansini also found that the bacilli of human tuberculosis were less virulent in pure culture than in tuberculous material or sputum.

Is it not also possible that the ignoring of mixed infections may invalidate conclusions based upon experiments made by Koch and others with pure cultures of the bacillus. These inoculation experiments to begin with do not and cannot reproduce the conditions usually met in natural infection. The animals used were perfectly strong and healthy, in no wise in a condition analogous to that of the child or adult who is unable to resist infection.

Again account must be taken of the varying virulence of the races of bacilli used, a bacillus of low virulence producing unimportant lesions. Taking all together, therefore, the negative results obtained were such as were to be expected, and the conclusions drawn were founded on data to which exception can be taken.

Considerations such as these lead us naturally to the consideration of the relationship of the human bacillus to those of the lower animals, and particularly to that of the bovine disease.

Tuberculosis in Man and in the Lower Animals.—Acute interest has been excited in the question of the intercommunicability of human and bovine tuberculosis by Koch's recent paper at the British Congress on Tuberculosis (1901).

Previous to that, one organism, the bacillus of mammalian tuberculosis, was looked upon as the proved cause of the disease in man and cattle. Another bacillus, somewhat distantly related to the former, was credited with producing fowl tuberculosis. Most other vertebrates are, or can be rendered, susceptible to tuberculosis, and the disease is described even in cold-blood animals such as fish.

In order to clear the ground we shall consider shortly avian and piscine tuberculosis in relation to the human disease.

Avian Tuberculosis.—The morphological and biological characters distinguishing the bacilli of this disease from the mammalian disease have already been detailed. Can any relationship to the mammalian disease and bacillus be proved?

Nocard succeeded in so modifying cultures of mammalian tubercle that they became like those of avian tubercle, and also resembled them in pathogenicity. He found that cultures of mammalian tubercle, if placed in collodion sacs and grown for a length of time in the peritoneal cavity of fowls, gradually became fatal to fowls and took on the cultural characters of avian tubercle. (Congress on Tubercul., Paris, 1898.)

Fischel and Mafucci (*Lubarsch u. Ostertag.* 1895, p. 233) were able to modify the appearance of mammalian and avian tubercle bacilli by cultivating on different media and at different temperatures. For example, if mammalian tubercle were grown on serum made from hen's blood, the resultant culture was like that of avian tubercle. They also found that mammalian bacilli when grown on eggs, and on boracic acid agar, or thymol-glycerine-agar, developed long filaments showing multiple branching. On dogs' blood serum a development took place like that of avian tubercle. More important still, by growing on boracic acid agar, Fischel obtained cultures of mammalian tubercle which no longer showed marked virulence for rabbits and guinea-pigs, but displayed effects in these animals like those of avian tuberculosis.

The evidence with regard to experimental infection of fowls with human tuberculous material is very variable and at times conflicting. There are some instances reported of natural infection of fowls with human tuberculosis. This is to a great extent opposed to the experimental evidence, probably from the fact that in experimentation all the conditions of the natural infection are not realised.

They may be infected with tuberculous sputum from their attendants, and tuberculosis has been observed in fowls reared in abattoirs, where they have been fed on contaminated meat or tuberculous viscera (Nocard).

The case reported by M. Cagny is well known. In *La Semaine Medicale*, 1888, he describes a case of transmission of human tuberculosis to poultry. A number of chickens belonged to a family, one member of which was suffering from pulmonary phthisis. The chickens all became tuberculous, and had to be destroyed. Tuberculosis of the liver was the principal manifestation found after death. M. Cagny learned that the sick man was in the habit of walking in the garden, and that it had been noticed that the chickens eagerly seized and swallowed the material he expectorated.

Sir Chas. Cameron (*Lancet*, July 1889) refers to this question, and quotes a case in which about fifty hens died within a period of three to four months. The deaths began to take place some weeks after the arrival of a consumptive patient in the house near which the fowls were kept.

Malleree (quoted, *Lubarsch u. Ostertag.*, Abth. ii. 1895, p. 235), relates a case in which hens developed tuberculosis from ingestion of the expectorations of a consumptive, and in their turn, being eaten raw, passed on the infection to a woman. A mother and child developed consumption. A young woman in a neighbouring house, during a period of four months, ate eleven hens which had died in the consumptives' house, and with the idea of obtaining as much benefit as possible, she consumed them raw. Several of the hens had developed tuberculosis of the intestine and liver from eating the tubercular expectorations. The young woman developed tuberculosis.

These few cases are related simply to show that there is a possibility of infection of poulty from man, and *vice versa*. In any case the risk seems to be slight, and may, in practice, be disregarded.

Kruse thinks that among the larger birds the parrot alone may be considered susceptible to mammalian tuberculosis.

Piscine Tuberculosis.—Bataillon, Terre, and Dubard have described a condition in the carp resembling tuberculosis, containing bacilli and giant cells. They separated the bacillus, which grew best at 23° to 25° C. Growth was rapid. It branched dichotomously. Kral and Dubard claim that they have converted human and avian tubercle bacilli into a form similar to that obtained from the carp by passage through fish, frogs, lizards, etc. The fish were supposed to have been infected from human tuberculous sputum expectorated into the water.

Relation of Human and Bovine Tuberculosis.—This subject is the field upon which the battle-royal is at present being fought in connection with tuberculosis. Is bovine tuberculosis transmissible to man? Is human tuberculosis communicable to cattle? Do the bacilli found in these diseases belong to the same species, are they sub-varieties of the same species, the variation being due to change of environment, the bacillus by prolonged residence in one species of animal taking on certain peculiarities, or are they totally different organisms?

Previous to Koch's oft-quoted speech at the London Congress, the close relationship, if not identity, of these bacilli was accepted as a settled fact, though it was recognised that bacilli from a bovine source were more virulent than those from a human source, and Frothingham, Theobald Smith, and Dinwiddie had discovered that cattle in general were immune to pure cultures of the human tubercle bacillus. Koch was also forestalled to some extent by Adami, who in 1899 drew attention to the fact that the evidence in favour of the view that bovine tuberculosis is transmissible to man was not so strong as was generally thought to be; that while cases did exist of such transmission, they were few in number. Even before Adami, similar views were enunciated by M. Alexandre (*Le Progrès Médical*, Paris, 29th Sept. 1894), who held, as a result of the examination of 20,000 cows in the Department of the Seine, that the consumption of the flesh and milk of our domestic animals was not the cause of the terrible mortality from tuberculosis among mankind, and that it was important that this once accepted belief be thoroughly rooted out of our minds.

Koch's paper was divided into two parts, the first dealing with the possibility of infection of cattle from the human disease, the second with the possibility of infection of man from cattle through ingestion of milk or flesh of diseased cattle. His conclusions were, firstly, that "human tuberculosis differs from bovine and cannot be transmitted to cattle"; and secondly, "that the extent of infection by the milk and flesh of tuberculous cattle and the butter made from their milk is hardly greater than that of hereditary transmission, and that it is inadvisable to take any measures against it."

A. In support of his first dictum, Koch brought forward very strong experimental evidence. He used cattle which had been proved by the use of tuberculin to be free from tuberculosis. He found that inoculation and ingestion of human tuberculous material and of pure cultures of the bacillus were invariably without result, except that, occasionally, small suppurative foci were found at the site of inoculation; whereas inoculation of bovine tuberculous material, as invariably, caused generalised tuberculosis.

He did not obtain such uniform results in feeding pigs with similar materials, as, in some of those fed with tuberculous sputum, "little nodules were found in the lymphatic glands of the neck, and in one case a few grey nodules in the lungs." With bovine material, on the contrary, they all, without exception, developed severe tuberculosis.

Similar results were obtained by injecting cultures into the vascular systems of asses, sheep, and goats, which, it must be noted, are looked upon as, comparatively speaking, insusceptible.

Möller of Danzig strongly supports Koch, as he has completely failed to communicate human tuberculosis to cattle.

Since Koch thus confirmed the previous conclusions of American observers, other workers have taken up the subject. In general they have confirmed the opinion that cattle are usually immune if pure cultures of the human bacillus are used, but we must clearly distinguish between experimental tuberculosis and natural tuberculosis. As Adami remarks, "We are realising more and more that the mere presence of virulent bacilli is not sufficient to set up the disease, that an equally important factor is the condition of the system. Thus, in connection with this very matter of tuberculosis in man, we know that while all are exposed to infection, at most 7 per cent die of the disease; those in good health resist infection; that this infection is specially liable to occur when the system has been lowered by another infectious disease, so that an attack of tuberculosis is notably liable to be dated from an attack of *la grippe*, pneumonia, typhoid, or other acute infection."

At the Congress, Lister, Nocard, Bang, and Sims Woodhead on the whole agreed that Koch had proved that infection of cattle from man seldom took place, and most authors since then have also written to the same effect; but experiments performed by Ravenel, Nocard, de Jong, Arloing, and others would go to show that inoculation even of *pure human bacilli* can produce tuberculosis in bovines, and there is a considerable body of evidence now to prove that if a material such as *sputum* from man, which causes a mixed infection, is used, tuberculosis can be readily conveyed to these animals.

1. Experiments with pure cultures of human origin.

Thomassen inoculated the anterior chamber of the eye of a calf with a pure culture of the human bacillus isolated from a case of joint tuberculosis. It was killed in six weeks, and a pretty well generalised tuberculosis was found.

Nocard (*La Revue Vétérinaire*, 1st Jan. 1902) produced a rapidly fatal meningitis by inoculating a small amount of human tubercle bacilli into the pia-arachnoid.

Intravenous inoculation produced the disease in a cow, whose normal resistance had been greatly reduced by chronic diarrhœa, but which was free from tuberculosis, as shown by the tuberculin test.

De Jong states that seven cattle became tuberculous as a result of the injection of pure cultures of the human bacillus. In only one of these was the disease grave and widespread; in four the lesions were retrogressive, and in the remaining two they were progressive (*La Semaine Médical*, 15th Jan. 1902).

Arloing reports three recent experiments. With a culture of human origin separated in 1896 he inoculated a young heifer and a calf intravenously. The calf developed a typical eruption of minute tubercles all through the lung. The heifer, after 120 days, was found to be only slightly diseased.

With a culture obtained from a case of pleurisy a calf two-and-a-half months old was inoculated intravenously. Death ensued in seventeen days. The lungs alone were involved, showing many young tubercles.

The third culture, isolated from a case of pleuro-pericarditis with pulmonary tuberculosis, was inoculated into a young bull intravenously. Death resulted in thirty-two days, the thoracic organs being principally involved.

Ravenel's experiments are of special interest. He made use of three cultures isolated from man. The first experiment would go also to prove that bovine tuberculosis can affect man.

It is well to quote his exact words, as the same ideas he expresses have occurred to others. "For several years past we have endeavoured to obtain material from cases of tuberculosis in children in which there was evidence of infection through the alimentary tract, reasoning that if children contracted tuberculosis through the ingestion of milk from diseased cattle, we would be most apt to find bacilli of the bovine type in these intestinal or mesenteric lesions. We have isolated from the mesenteric gland of a child, in whom the evidence of primary intestinal infection was clear, a culture which has for cattle the most intense pathogenic power."

"Two calves inoculated into the jugular vein and peritoneal cavity died in nineteen and twenty-seven days respectively; and a grown cow which was inoculated similarly died in eighteen days. All of these animals exhibited marked symptoms from the day of inoculation. Examination of the lesions, both macroscopical and microscopical, leaves no doubt that the animals succumbed to a pure tuberculosis."

"What interpretation is to be given to these remarkable results? One of two propositions must be admitted: either we have found a human tubercle bacillus having a pathogenic power for cattle quite as great as any bovine germ, or else we have found in the mesenteric gland of a child the bovine tubercle bacillus. If we accept the law of diagnosis laid down by Koch, namely, the inoculation test, the latter is the true explanation. I myself am strongly of this opinion" (*Univ. of Pennsylv. Med. Bull.*, May 1902).

Ravenel separated another culture from the mesenteric glands of a child and found that this was unusually virulent when inoculated into guinea-pigs, rabbits, puppies, a grown dog, and a calf. The result in the calf led him to believe that the usual method of employing only guinea-pigs and rabbits in testing the virulence of the tubercle bacillus does not always give entirely satisfactory results.

It has occurred to others, for example, Adami and Higgins, that the virulence of a given culture of human bacilli might be increased by successive passages through cattle.

Ravenel and Leonard Pearson proved this. At first, two calves were inoculated at intervals of a week. One lived for 106 days, and in the case of the other life was more prolonged. From caseous bronchial glands in one of them another calf was inoculated, which lived forty-eight days. The experiment was repeated with material from this calf, and the inoculated animal died in twenty-three days. Two other calves in succession were employed, the result demonstrating that a great increase in virulence had been attained.

2. As we have already remarked, however, these experiments do not reproduce the factors met with in natural infection. It is recognised that the chief danger is from a mixed infection. For example, in respiratory tuberculosis in man infection takes place from virulent sputum, either dried and conveyed about in dust, according to Cornet, or in a fine spray, projected during speaking, coughing, or sneezing, according to Flügge.

If, then, we can induce tuberculosis by a mixed infection, carrying out experiments either with sputum or with material from the lungs of tuberculous subjects, we would reproduce more closely, though still not quite satisfactorily (seeing that the animals used are healthy), natural conditions.

Chauveau (*Congt. Tuberc.*, Paris, 1891) with such material produced tuberculosis in a hiefer six months old; in another eleven months old; and in a young bull about ten months old. In these animals the material was given in the food. He also was successful in infecting a calf by intravenous injection. On subcutaneous inoculation, in every case a typically tuberculous tumour developed at the seat of inoculation, no general infection, however, following. This does not accord with the statement of Koch, who referred to these experiments of Chauveau among others as proving that animals which were fed with human tuberculous material never developed tuberculosis.

Ravenel (*Lancet*, Aug. 1901) inoculated four calves of nearly the same age, intraperitoneally, with a uniform quantity of tuberculous sputum from different sources, but all containing numerous bacilli. One calf was unaffected. Of the remaining three, in which infection had taken place, two showed very extensive lesions of the nature of "grapes" or "perlsucht."

In the case of pigs, he found that five out of six inoculated with human material died after a considerable time. From these pigs he inoculated others, producing a rapidly fatal diffuse tuberculous pneumonia, the virulence of the organism having apparently been raised by passage through the former animals.

To compare with these results he inoculated other animals under similar conditions with an equivalent dose of bovine tuberculous material, and found that this was much more virulent for all animals.

Böllinger (*Munch. Med. Wochensch.*, Jan. 1894) records an experiment performed long before. He inoculated a healthy calf—three months old—intraperitoneally with tuberculous fluid from a human being. Seven months later characteristic "perlsucht" of the peritoneum was found.

Délèpine, by inoculating a mixture of tuberculous sputa into calves, has succeeded in causing tuberculosis.

Klebs, Kitt, and Crookshank have all succeeded in producing tuberculosis in calves by intraperitoneal injection of human tuberculous material. Sidney Martin fed six calves with tuberculous sputum. Four of these showed lesions of the disease when killed, two remained healthy.

All these experiments, then, show that Koch's first statement, that human tuberculosis cannot be transmitted to cattle is "erroneous and untenable" (Ravenel).

B. The second and more important question is whether bovine tuberculosis is transmissible to man.

Koch states absolutely that this transmission does not occur, or but rarely.

"Though the important question whether man is susceptible to bovine tuberculosis at all is not absolutely decided, and will not admit of absolute decision to-day or to-morrow, one is, nevertheless already at liberty to say that, if such a susceptibility really exists, the infection of human beings is but a very rare occurrence. I should estimate the extent of infection by the milk and flesh of tubercular cattle, and the butter made of their milk, as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it."

He brings forward a very strong argument in his favour when he says further "If the bacilli of bovine tuberculosis were able to affect human beings, many cases of tuberculosis caused by the consumption of alimenta containing tubercle bacilli could not but occur among the inhabitants of great cities, especially the children, and in reality this is not the case."

At the recent congress on tuberculosis held at Berlin in October 1902 Koch still upholds his former contentions, and is still convinced that his view is correct. Due consideration must be given to the opinions, deliberately formed, of a man in his leading position, and the evidence against them must be very carefully weighed. Möller of Danzig strongly supports Koch.

Even at the outset, however, we may decline to accept statistics, wheresoever originating, as applicable to every country; and we are warranted, even granting that Koch were right so far as his own experience, or experience in Germany, is concerned, in refusing to allow his conclusions to dominate or alter our measures adopted after long discussion for the prevention of tuberculosis in Britain unless or until statistics from British sources applicable to our own circumstances and case show these measures to be mistaken. Even statistics gathered from different parts of Germany do not agree, and in different parts of Britain the incidence of tuberculosis varies. In London and Edinburgh the disease is common. In other large cities, *e.g.* Birmingham, it is not so rife.

Previous to the 1901 Congress the relationship, if not identity, of the bacilli was accepted as a settled fact, though it was recognised that the bacilli from a bovine source were more virulent than those from a human source.

We had also recognised the fact that respiratory infection was much more important than alimentary infection, even in children; but we were not prepared to accept, off-hand, Koch's dictum that the possibility of infection from infected alimenta is a negligible quantity.

As Montizambert remarks in his report to the Canadian Minister of Agriculture, "We shall all rejoice if Koch is proved to be right, and our duty is to hope that he is. But the question is, can his theory be safely accepted? That can only be decided by an examination of the facts upon which it is based. No man, however great, can lay down a law in science by the mere weight of his opinion."

That Koch's conclusion is incorrect, at all events so far as Great Britain is concerned, is proved by a considerable body of clinical and statistical evidence; and even in other countries evidence is obtainable which warrants us in doubting the absolute correctness for all peoples and climes of his sweeping statement.

In some countries, as in our own, the chances of infection are greater than in Germany. We must remember that, whereas the use of boiled milk is very common, if not the rule, in Germany, it is the exception in Britain. No doubt the use of "Pasteurised," "sterilised," or cooked milk is increasing in this country, but the flavour of boiled milk is not grateful to the national palate, and we still prefer raw milk with all its extraneous contents, derived from the cow, the milker, the byre, and later from the dust of streets and occupied apartments. As has been remarked, there is no article of food in common use which is more exposed to contamination in its progress from the producer to the consumer, an article which is produced sterile, and in nature is intended to be consumed without chance of contamination.

This is a point of very considerable importance which tends to affect the incidence of the disease.

Again, in healthy subjects consumption of raw milk, with all its concomitants, causes no evil effects, as is proved by the fact that probably all of us have unwittingly partaken of tuberculous milk. Clifford Allbutt has tested this by allowing his own family and servants, as well as two families living near, to consume the highly bacilliferous milk of a favourite cow. Not one individual developed the slightest trace of tuberculosis. This is perfectly credible, but the conditions of the experiment, if so it may be called, do not fit the case. Pasteur, in investigating a disease of silk-worms, traced the evil to a micro-organism, but a far more valuable and suggestive outcome of his researches was the discovery that so long as the silk-worms were in health they laughed and grew fat on the micro-organisms; only when they deteriorated in condition and suffered from digestive derangement could they enter and cause the disease. Similarly, healthy individuals do not readily acquire tuberculosis, but only such as are predisposed through a general weak condition of body, or through bad environment, or who are the subjects of intestinal or gastric catarrh. The majority of cases of respiratory tuberculosis may be left out of account, as these usually result by infection from a previous case in man, though all cases of respiratory tuberculosis must not be looked upon as necessarily respiratory in origin.

A great deal of information is gained from examination of suspected cases after death, but here again it must not be forgotten that only the very severe cases of abdominal tuberculosis come to the post-mortem room. Tuberculosis, and particularly abdominal tuberculosis, tends very frequently to heal. Records of necropsies at home and abroad indicate that traces of healed tuberculous lesions exist in from 20 to 50 per cent of all persons dying of other diseases.

Taking the case of abdominal tuberculosis specially, Sir William Gairdner, in *Lectures to Practitioners*, says: "A far too grave prognosis is arrived at in cases of tabes (mesenterica), consequently many cases of tubercular disease, not only of the mesenteric glands, but also of the peritoneum, recover, only the graver cases succumbing."

It is a matter of common knowledge and experience that cases of undoubted abdominal tuberculosis with, frequently, no evident trace of tuberculous mischief elsewhere, will heal after, or are cured by, laparotomy.

Churton (*Lancet*, 1897, i. p. 594) gives instances of rapid absorption of tuberculous masses in the abdomen *without* operation, and others at the same meeting related similar cases coming under their own observation.

Woodhead (*Lancet*, 1888), after quoting statistics, says, "It is evident that tubercular conditions of the abdomen are much more common than can be inferred even from the figures quoted."

Hence post-mortem statistics must not be taken as indicating the prevalence of abdominal tuberculosis during life.

Koch states that he has only seen two cases of undoubted primary intestinal tuberculosis, and Müller, from 500 autopsies on children at Munich, concludes that the intestines are seldom the avenue for tuberculous infection in children. Though this, again, is not the experience of physicians and pathologists in this country, we must note that ingestion tuberculosis does not limit itself to producing intestinal ulceration, but, as all of us have seen, the organism may pass through the wall of the intestine without markedly affecting it, and cause a tuberculous peritonitis, or more often tuberculosis of the mesenteric glands. Following on this, other groups of glands may be infected, such as the retro-peritoneal, the cœliac, posterior mediastinal, bronchial, and root glands, and these, breaking down into a bronchus or vessel, may give rise to a secondary respiratory tuberculosis, or to a generalised tuberculosis, just as the condition may travel in the reverse direction from primarily infected bronchial glands to mesenteric glands.

Once more, in ingestion tuberculosis the bacilli may invade by way of the pharyngeal and faucial tonsils, and proceed downwards along the cervical chains of glands to the mediastinal and root glands. This course has been demonstrated experimentally in the pig by Dr. Sidney Martin, who failed to infect by inhalation of bacilli, but found that in feeding experiments the rule was that invasion took place by way of the tonsils, which are very prominent in the pig. By many, chronically enlarged tonsils in man are looked upon as predisposing to pulmonary tuberculosis. Sidney Martin lays great stress on his experiments as proving the etiology of the analogous cases of "strumous" glands in children (Report of Royal Commission on Tuberculosis, 1895-96). All practitioners have shared the experience of Wohlgemuth when he states that in such cases removal of the affected glands removes the focus of disease, and cures the patient.

Böllinger, F. Hueppe, Weleminsky, and Sims Woodhead also emphasise the importance of this method of infection in children.

The last named says (*Lancet*, '94, ii. p. 958), "I am driven to the conclusion that this method of infection of the glands through the tonsils must be of comparatively frequent occurrence, especially in children living under insanitary conditions, and subjected to various devitalising influences." Further referring to the fact that in pigs the lungs may be affected secondarily to tuberculosis of the pharyngeal tonsillar structures through the connecting chains of glands, he says, and the writer's own experience supports his statement, "I have seen a similar line of invasion in children, sometimes alone, but usually associated with tubercle extending from the mesenteric glands in the direction already indicated. In all these cases, it would appear that the glands at the root of the lungs become tuberculous and caseous before the pulmonary tissue itself shows any evidence of disease." Of course, in such cases, one must examine the lungs very carefully to exclude the presence of any old dried-up tuberculous focus or scar indicating disease of the lung antecedent to that in the glands.

Again, the same author says (*loc. cit.* p. 960), "I have seen in case after case in children, and in animals fed on tuberculous material, the lungs markedly affected, but in a large proportion of these cases it has been possible to trace the course of invasion back from a caseous or old calcareous mesenteric gland, through the chain of retro-peritoneal glands up through the diaphragm to the posterior mediastinal and bronchial glands, and so on to the lungs."

Therefore, as has already been remarked, all cases of respiratory tuberculosis must not necessarily be looked upon as primarily so, and are not all due to inhalation.

Passing from this criticism of Koch's statements, which, when all is said and done, are based on negative experimental evidence only, we may proceed now to examine positive evidence in favour of the contention that tuberculosis may be transmitted to man from cattle.

Speaking generally, the great danger to be apprehended is from *dairy* cattle, which are kept to a large extent in ill-ventilated byres and cowsheds, rather than from cattle kept in the open; the former being herded together under conditions favouring the transmission of disease from one to another, and its retention in a fairly constant ratio.

"In places where cattle are allowed to graze at liberty in our Alps and in marshes, uncooked milk will often be drunk with impunity, but in the low country, and in towns where the dairy cattle are always crowded together in damp cow-houses and infection spreads from animal to animal, Koch's assertion that there is no cause for uneasiness would be an invitation to carelessness which would undo all that has been accomplished." (F. Hueppe, *Lancet*, 1901, ii. p. 613.)

As great a proportion as 50 to 70 per cent of cattle kept under such conditions has been found affected with tuberculosis by the tuberculin test, and the udders are found tuberculous in ½ to 2 per cent.

As to the general question, whether dairy cattle are responsible to any extent for the prevalence of tuberculosis in the human subject, we may first cite the investigations of E. F. Brush (*Archiv. Pædiatr. Philad.* 1890, p. 551), who considered the coincident geographical distribution of tuberculosis and dairy cattle.

He shows that in lands like Egypt the indigenous inhabitants retain immunity while associating for long periods with consumptive immigrants; while, on the other hand, in regions like Australia and the Sandwich Islands, the inhabitants have become infected after the introduction of dairy cattle. Referring to China, he speaks of the poor Chinese as a people who do not use milk, while the Tartars in that country are milk and meat consumers; and, therefore, the observations of medical men are very confused, and they confess that they cannot understand why the disease prevails among the dominant Tartar class and not among the poor Chinese, who, according to all preconceived notions, ought to be tuberculous.

In South America, where cattle are exceedingly numerous, but the use of milk almost unknown, or used only after being boiled, the natives enjoy still a large immunity.

Contrasting Spain and Morocco, where climate and other conditions must be nearly equal, he finds that Morocco, where there are no European dairy cows, is exempt from tuberculosis; while in Spain and Portugal, where dairying is carried on in the European style, tuberculosis prevails. He expresses a belief that dairy and beef cattle could be bred in such a way as to eliminate tuberbulosis.

If this be the case, it is difficult to deny the connection between dairy cattle and the prevalence of tuberculosis.

Statistical Evidence.—The evidence of the mortality tables of the Registrar-General might be cited in support of the prevalence of ingestion tuberculosis, though according to M'Fadyean we should not lay too much stress upon it.

There has been in Great Britain during the last forty-five years a reduction of 27·9 per cent in the deaths from all forms of tuberculosis. The reduction in deaths from phthisis pulmonalis reached 66 per cent, while the corresponding reduction from tabes mesenterica only reached 3 per cent. In this connection Sir Richard Thorne-Thorne says, "In considering the latter cause of death, we are dealing with a totally different state of affairs. The matter, too, assumes a still more serious aspect if we limit ourselves to the first year of life, when milk is most largely used as food, for then we find that the reduction in the rate of deaths from the various forms of tuberculosis, which reduction has been going on at all ages for about half a century, not only disappears, but is actually transformed into a large increase, reaching no less than 27·7 per cent. This in itself is grave enough, but its significance is still further increased when we remember what are the circumstances under which this increase in the rate of deaths from tabes mesenterica has gone on synchronously with the decrease in that of other forms of tuberculosis."

Adami, criticising these statements and figures, cannot otherwise explain them save on the supposition that impure and infected milk is an essential factor in the production of abdominal tuberculosis in young children. Not all these cases, it is true, should be regarded as due to milk. The habit of expectoration by adults, the creeping habits of children, their liability to put everything into the mouth, lead to a very great possibility of infection with human bacilli through the digestive tract. But admitting this, and admitting even that the hygiene of the house in Great Britain has not improved at the same rate as has the hygiene of the factory and of work places in general—an improvement which is the main cause of the decrease in tuberculosis in adults in Great Britain—if mesenteric tuberculosis were in the main due to infection with human tubercle bacilli, then, with the lessening of tuberculosis in adults, there ought certainly to be a corresponding diminution in the number of cases of tabes mesenterica in children, and *this has not occurred.* (*Canadian Blue-Book,* A. 1902. *Sessional Paper*, No. 15, p. 126.)

The examination of post-mortem records in Hospitals for Children and statistics based on these give important information.

It has been long taught and believed that, in children, ingestion tuberculosis was by far the commoner form in which the disease occurred. That this is not so has been abundantly proved by recent statistics. These statistics, obtained from the post-mortem room, must of course not be taken as indicating the relative prevalence of inhalation and ingestion tuberculosis during life, the proportion of ingestion cases being almost certainly higher from the reasons already given.

In the Hospital for Sick Children in Great Ormond Street, London, Dr. George Still was able to determine the channel of infection with some degree of certainty in 216 cases, and of these he refers 29·1 per cent to alimentary tuberculosis, the bacillus entering through the intestine. In the remainder, invasion had most probably taken place through some part of the respiratory passages.

In an investigation undertaken in 1899, in ignorance of the simultaneous work of Dr. Still, but with the same idea in view, the ascertaining of the proper proportion of inhalation to ingestion tuberculosis, and feeling that the ratio of ingestion tuberculosis had been placed too high, the writer examined the post-mortem records of the Royal Hospital for Sick Children in Edinburgh for a period of about sixteen and a half years. Out of 855 post-mortems, he found that 355 were for tuberculosis. Out of these 355 cases, thanks to the excellent manner in which the records had been kept, he was able with some certainty to make out the primary focus in 331 cases. Of these 331, 93, or 28·1 per cent, had to be referred to alimentary or ingestion tuberculosis. The result shows a remarkable agreement with that obtained independently by Dr. Still, and this circumstance increases its importance. In all these cases the bacilli had entered by some part of the alimentary tract, including the pharynx and tonsils.

Examining the condition of the intestine in relation to that of the mesenteric glands, the following results were brought out. Forty-five cases showed ulceration of the intestines prior to affection of the glands; twelve showed caseation and matting of the glands apparently of older date than the condition in the intestine, the latter being quite healthy in five cases. (*Edin. Hospital Reports,* 1900.)

In this connection we must again quote Sims Woodhead. "In 14 out of 127 cases the mesenteric glands only were found affected. No tubercle was found elsewhere in the body. In these cases the glands had become calcified. There was no ulceration or cicatrisation in the intestine; no peritonitis; no secondary tuberculosis in any other part of the body; so that the tuberculosis in the mesenteric glands must be looked on as the primary lesion." (*Lancet,* 1888.)

Again, though Böllinger and others consider the intestine very resistant to infection, "the lymphoid structures in the alimentary tract are very vulnerable. They appear to be more readily denuded of their epithelium than other portions of the tract, and in addition, lymphocytes passing into them can take with them virulent tubercle bacilli" which give rise to ulceration in the lymphoid structures, or passing through them, to tuberculous adenitis of the mesenteric glands secondary to or preceding the intestinal ulceration. (Sims Woodhead, *loc. cit.*)

Böllinger also states that "tuberculosis of the peritoneal lymphatic glands occurs oftener in children than in adults, the cause for which is probably to be sought for in the feeding of young children with the milk of tuberculous cows.

After the meeting of the Tuberculosis Congress, the writer took the opportunity of examining his records at the Royal Hospital for Sick Children, Edinburgh, covering the period from June 1899 to August 1901, and found that out of 150 post-mortems 43 were for tuberculosis, and of these, 11 or 25·6 per cent, were alimentary in origin, thus affording still further proof of the accuracy of the former observations. He tried carefully to exclude any cases in which the etiology was in the least doubtful.

Adding these 43 cases to the 331 cases formerly reported, we have a total of 374 cases, and of these 104 or 27·8 per cent were alimentary in origin.

Other observers furnish somewhat similar statistics. Dr. Carr out of 220 autopsies on tuberculous children at the Chelsea Children's Hospital found that 16·7 per cent showed evidence of primary abdominal infection. Dr. Guthrie (*Lancet,* '99, i. p. 286), at Paddington Green Children's Hospital, found in a series of 77 cases that 26 per cent had been infected through the intestine. (Both quoted by Dr. Still, *Practitioner,* July 1901.) Kossel (*Zeitsch. für Hygiene,* Bd. xxi. 3, 59) found in 14 cases of tuberculosis in children, varying in age from 1½ to 10 years, that the primary focus in 4 cases was in the mesenteric glands. There was no symptom of this during life.

Hueppe places the incidence of ingestion tuberculosis at 25 to 35 per cent.

We can therefore fall back upon a considerable mass of statistical evidence, and even allowing a margin for error, which, it must be remembered, is probably more than counterbalanced by the known fact that the prevalence of abdominal tuberculosis during life cannot be limited by post-mortem statistics, we have still very strong grounds to go upon in refusing to accept without further more positive proof Koch's statements with regard to this form of tuberculosis.

CLINICAL EVIDENCE.—It is improbable that flesh, even from cattle with very extensive tuberculosis, causes the disease in more than a very small minority of cases.

"It is known that 'Knackers,' a class of people very liable to the consumption of tuberculous meat, suffer less from tuberculosis than the general population." (Kustner, *Munch. Med. Wochenschr.* 1889.)

It is also stated that Jews suffer less from tuberculosis than Christians, and this has been explained by their greater care in the selection of meat.

Tuberculosis of muscle is very rarely met with. From experiments Nocard holds "that muscles either destroy or digest injected bacilli of tuberculosis, or at least render them innocuous."

Whatever be the reason, the fact remains that muscle is markedly immune to tuberculosis. Possibly the explanation may not be unconnected with the continual unrest of this tissue, and to the fact that it is plentifully supplied with fresh oxygenated blood.

As Sidney Martin points out meat is usually infected by the knife of the butcher, which cuts through broken down caseous glands, and smears the tuberculous material over its cut surface. Experiments in which meat or meat-juice of tuberculous cattle have been inoculated into, or ingested by other animals, are generally productive of results so variable as to be untrustworthy; the bacilli, in the cases in which tuberculosis has resulted, being apparently derived from tuberculous foci in the intermuscular planes or in adjacent glands. Such experiments have been performed by Steinheil (*Munch. Med. Woch.* 1889), Sidney Martin (Royal Commission on Tuberculosis, 1895-6), and others.

It is quite another matter, however, where *Milk* is concerned, and much evidence in support of the virulence of tuberculous milk has been collected since Klebs and Gerlach first proposed, in 1868, that the milk of tuberculous cows may also be an agent of infection, and went so far as to hold it specially accountable for the tuberculosis of children.

Nocard summarises the question of infection by means of milk thus:—

1. "Milk of a tuberculous cow is virulent only when the udder is the seat of tuberculous lesions.

The udders are affected in from ½ to 2 per cent of tuberculous cows.

2. "Milk is dangerous only when it contains a large number of bacilli, and is ingested in large amount."—*The dose must be large.*

3. "In practice, this danger exists only in the case of individuals in whom milk is the exclusive or chief article of diet—for example, in infants and invalids.

4. "That, to avoid the danger, it suffices to boil the milk before use."

Bang has found that on churning, most of the bacilli are carried off in the butter-milk (*petit lait*), but that a certain number remain always in the butter and cheese. Therefore Nocard believes that butter and cheese, even from an unknown source, may be eaten without fear, the number of bacilli being in any case small, and readily overcome in the alimentary tract. The common presence of acid-fast bacilli in milk and its derivatives must not be forgotten in connection with this question.

To sterilise the milk one need not expose it to a temperature of 100° C. Bang has found that exposure to a temperature of 85° C. for five minutes kills all the bacilli—they are often killed at 80° C.; by raising the milk to 70° C. for five minutes they are not killed, and can still give tuberculosis to animals if inoculated into the peritoneal cavity, but their vitality is so profoundly affected that they are quite incapable of causing tuberculosis in animals which ingest even large quantities of milk treated in this way. The same result is obtained by heating the milk to 65° C. for fifteen to twenty minutes.

While it is granted that bacilli are most numerous and virulent in the milk of cows whose udders are extensively diseased, it must be remembered that bacilli, apparently true tubercle bacilli, have been found in the milk of tuberculous cows in which the udders were healthy, and Benda has demonstrated them in the cells lining the lacteal ducts of such animals. In such cases the numbers present, particularly when the milk is mixed with the rest from the herd, are usually too small to cause any infection.

The bacilli in milk may be derived either directly from the diseased cow or indirectly from the inspissated sputum of a phthisical patient, but in the latter case they can seldom collect in large quantities in the milk; and remembering that a large dose is necessary to convey the disease, the probability is that in most cases in which milk is to blame the crowds of bacilli have been derived directly from affected cows.

Many cases of infection in man from the use of tuberculous milk are reported in medical literature. Some of these are well known, for example those mentioned by Nocard and Ollivier, but a few less familiar cases may be noted.

Baum (*Lubarsch u. Ostertag*, 4 Jahrg. 1897, p. 868) describes several cases.

A fourteen-year-old girl of healthy parentage, quite healthy in childhood, died of tuberculosis of the larynx, ileum and cœcum, slight of lungs. It was found that she had been drinking warm milk from a tuberculous cow.

Two children of healthy parents throve until weaned, and soon thereafter died of tuberculous meningitis. The milk given was from tuberculous cows.

Another child, six months old, of healthy parents, died of tuberculous meningitis. It had been brought up solely on milk from a tuberculous cow.

A boy, four years of age, died of tuberculosis of the abdominal glands, of the serous membranes, and of the lungs. He had been fed on warm milk from a tuberculous cow.

Johne (*loc. cit. idem*) gives a case in which one child two and a half years old, who had been fed on tuberculous milk, died of acute miliary tuberculosis. Another child of the same family, who had not been exposed to the same infection, remained sound.

Ebers reports six cases, collected by several observers, of tuberculosis in children, attributed to the milk of tuberculous cows. (*Lubarsch u. Ostertag*, 1899.)

Bang, through inquiries in Denmark, has collected reports of nine persons in whom infection could be traced with reasonable certainty to milk from tuberculous cows. (Quoted by Strauss.)

Von Ruck reports the cases of a father and child which are very convincing, and says that he has observed several others in which there was very good reason to believe that milk was the agent of transmission of the tubercle bacillus. (*Jl. of Tuberculosis*, Ap. 1899.)

Klebs and Rievel have recently reported two cases which came under the observation of the former. A healthy young man employed by Klebs to assist in making some investigations on milk infection had the habit of drinking the milk of the tuberculous cows used in the experiment. In a few months he died of miliary tuberculosis. The second case was of a child who died at the age of two years of tuberculosis of the cord and meninges. This child was the only one out of six fed on cow's milk and the only one that developed tuberculosis. (*Deut. Thierartz. Woch.* Jan. 18, 1892. Quoted by Ravenel.)

Similar cases might be multiplied.

Epitomising the case against milk, we may conclude that tuberculous milk can cause disease, but as a rule, only in weakly individuals whose resistance is greatly lowered, and secondly, that such milk is dangerous only when the bacilli are present in great numbers or when it is ingested for a length of time.

NATURAL INFECTION BY THE CUTANEOUS SURFACE

It is well known that pathologists and assistants in post-mortem rooms often develop tuberculous warts on the fingers. It is also known that butchers develop similar warts, the infection having been received in cutting up the carcases of tuberculous cattle.

Veterinary surgeons are also occasionally inoculated in a similar way. Take, for example, the well-known cases reported by Pfeiffer and Tscherning.

Ravenel, in the paper in the University of Pennsylvania *Med. Bull.*, July 1902, formerly referred to, gives the four following additional instances.

Dr. Kurt Mueller, *Zeitsch. f. Fleisch-u. Milchhyg.*, Feb. 1902, a surgeon of Erfort, describes the cases of two healthy young men who were under his care. Both were butchers, and in both cuts were sustained while working on tuberculous cattle, the wound opening the synoval sheath of a tendon in the hand. In each case an operation was necessary, and it was found that the wall of the sheath, as well as the tendon itself, were thickened, while upon them were large numbers of yellow nodules, proven to be tubercles by microscopical examination. These tubercles were placed very thickly near the scar, gradually becoming fewer as the scar was left. In one of the men the trouble extended from the finger to the forearm, and there was some evidence of tuberculosis even at the muscular attachment of the tendon. In the second case the tendon was attached to the sheath, and the disease limited to an area 10 cm. in length. Examination of the removed tissue proved the presence of tubercle bacilli. Both of these men had good family histories, and were free from tuberculosis elsewhere, so that Dr. Mueller has no doubt that they were inoculated with bovine tubercle bacilli.

De Jong, *La Semaine Med.*, Jan. 15, 1902, observed the case of a man who injured his finger while examining the mesentery of a tuberculous cow. The wound did not heal, the edges became indurated, and considerable swelling ensued, with pain which increased steadily and failed to yield to ordinary treatment. Curettage and cautery were finally used with success. In the scrapings tubercle bacilli were demonstrated.

In Berlin two men who are employed in the slaughter-house to carry the condemned tuberculous meat to the place where it is destroyed, have developed tuberculosis of the skin of the hands. At a recent meeting of the Medical Society of Berlin, Prof. Lassar, *La Semaine Med.*, Jan. 1, 1902, presented cases of verrucous tuberculosis of the skin. He had observed this type of skin tuberculosis in butchers who had handled tuberculous meat. Of thirty-four cases seen by him four were in butchers ; while on the contrary, among those affected with other forms of tuberculosis localised to the skin of the hands, none belonged to this calling. Liebreich agreed with the view taken, and said he had been able to assure himself that verrucous tuberculosis of the skin was much more common among those whose duties require handling tuberculous meats than among others. Blaschko spoke of the case of a cook seen by him in whom a tuberculous lesion followed the prick of a piece of bone.

Drs. Joseph and Trautmann, *Deut. Med. Woch.*, March 30, 1902, report three cases of verrucous tuberculosis of the skin occurring among employees of the municipal abattoir in Berlin, who worked exclusively with tubercular animals.

M. P. Krause (*Munch. Med. Woch.*, June 24, 1902, quoted in *Gazette des Hopitaux*, July 3) reports a case of infection through a skin wound.

A man, 30 years old, of robust constitution, with no family history of tuberculosis, a worker in a slaughter-house, had always enjoyed perfect health. Three years ago he injured the right thumb with a splinter of wood, and immediately afterwards had to skin a tuberculous cow. After several days the right arm commenced to swell, the swelling progressing slowly till it reached the axilla. He was treated by several physicians, all of whom diagnosed lymphangitis and tuberculous glands. A series of cold abscesses had to be opened. Examination of a gland and of a piece of ulcerated skin confirmed the diagnosis.

Lastly, the patient was examined at Professor Kast's medical clinique at Breslau. The lungs and all the other viscera were found healthy. In the right axillary fossa palpation revealed a small induration; below this were several indolent glands of the size of haricot beans. At the inner border of the biceps there was a gland as large as an almond, which was removed and submitted to microscopic examination. It contained tubercle bacilli and giant cells. One cannot doubt that in this case there was an infection from a bovine source.

It would seem, therefore, that infection through wounds is not so uncommon as was formerly supposed, and that bovine bacilli can apparently be implanted even in healthy tissues.

Conclusions.—Consideration of the whole subject leads us to conclude that the bacilli found in tuberculosis in man, cattle, other mammals, and most probably in birds, are closely related, most probably descendants of one original germ modified by successive passage through individuals of a certain species.

Bacilli by this successive passage through the same species have acquired a special virulence for animals of that species, and have lost their virulence to some extent for animals of any other species. Thus the bovine bacillus is more virulent for bovines and the lower mammals than for man, who is naturally insusceptible.

The three bacilli have gradually attained morphological and biological characteristics which are transmissible to their direct descendants, and distinguish them from each other.

Their characters, nevertheless, by suitable treatment can be approximated.

Bovine and human tuberculosis are, under favourable conditions, intercommunicable. "Therefore, bovine tuberculosis is a menace to the health of man; to what extent we cannot at present positively define, but that it does really exist cannot be denied. There has been exaggeration in the past, but however great this may have been, it does not now justify any attempt at belittling the risk, and it is folly to blind ourselves to it" (Ravenel).

Infants, those of early ages, and weaklings are specially liable to be infected by bovine tubercle bacilli, and chiefly through the agency of milk. The statistics bearing upon the increased frequency of tuberculosis in infants, and upon the relative frequency of ingestion tuberculosis in children, must be accepted as fairly conclusive evidence on this point. Even if it could be shown that tuberculosis was not conveyed by milk, the precautions taken in the past have had such an important result in lessening the mortality from a still more fatal disease—diarrhœa—that we are justified in continuing them.

Until the question is finally decided, the duty of guarding our milk supply is laid as heavily upon us, and no relaxation can be allowed in our attempts to obtain a healthy supply, particularly for children.

Tumours.

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ONCOLOGY is a branch of pathology which is particularly concerned in the investigation of the structure (histogenesis) and causes (pathogenesis) of those abnormalities of animals and vegetables known as tumours. The term tumour is very ancient and only signified a "swelling," but the careful microscopic investigations conducted by histologists with the aid of differential staining of the tissues, and the study of the relations of micro-organisms to those swellings called tumours has led to a revolution of our knowledge, and gradually the term has been stripped of its former wide significance; although in clinical work the term is not likely to completely disappear, it has lost its importance to the pathologist. Even with our modern knowledge it is impossible to frame a definition of a tumour, although we set very clear limitations to the use of the word.

In this article the conditions which will be described under the heading "Tumours" are local irregular swellings of the connective-tissue system (fat, cartilage, bone, etc.), which are not due to recognised infections such as tuberculosis, syphilis, glanders, actinomycosis, and the like; abnormal conditions of secreting glands, skin, and mucous membrane known as adenomata and cancer; and the remarkable group known as dermoids. Each of these groups will receive separate consideration. One of the earliest classifications of the heterogeneous formations termed tumours, arranged them into a malignant and an innocent division. The malignant tumours inevitably destroyed life, whereas innocent tumours did not display such destructive propensities. Although this division was founded solely on clinical observation it is sound, because tumours belonging to the connective-tissue group, as well as those of the epithelial group which display malignancy exhibit, in many instances, structural characteristics which enable competent histologists to recognise them; thus the two terms innocency and malignancy, as applied to tumours, are of the greatest significance in relation to clinical medicine. The most satisfactory method of classifying tumours would be to take their cause as a basis, but as we are absolutely ignorant of the pathogenesis of tumours, we have to rely on their structure for taxonomic purposes. It is noteworthy that whenever the cause of a disease characterised by tumour-formations is detected, that particular disease is removed from the list of tumours; one of the most striking instances of this is the parasitic disease known as actinomycosis, which used to be classed with the sarcomata. The study of the minute structure (histology) of tumours led to a great increase of knowledge concerning them, the earliest investigators in this field being J. Müller and Virchow.

The use of animal bodies for food induced men to apply names to the various parts, so that in the vulgar tongue bone, skin, fat, gristle, and the like are thoroughly familiar structures. The anatomist speaks of nerves, muscle, tendon, artery, and so forth; but the discoveries of the microscope revealed that the body is composed of fundamental tissues, which enter into the composition of organs of the most diverse form and function. The basis of animal bodies consists of what is known as connective tissues which comprise bone, fat, cartilage, fibrous, muscular, and nervous tissue, and a peculiar material which permeates the body and enters into the composition of every organ, and is known as connective tissue. This ubiquitous web is stout and strong where it forms fascia and periosteum, but extremely delicate in the nervous system, and reaches such extreme fineness in the retina that it needs careful preparation to render it perceptible even to the microscope. The connective tissues practically form the framework of the body, and constitute a sort of sustentaculum in the compound organs such as the intestines, liver, kidney, and the like for the support of epithelium, and as a mesh in which blood-vessels and lymphatics can ramify to supply the liquid tissue (blood), from which the cells can obtain material to form the secretion characteristic of the particular gland to which they belong. The careful and critical study of the minute (microscopic) structure of tumours revealed that they were composed of material exactly like that of the normal tissues of the body, and pathologists began to realise that the structure of a primary tumour invariably corresponded with the tissue in which it arose; for example, an osseous or bony tumour arises from bone, a fatty tumour from fat, a cartilage tumour from cartilage, and so on. This is known as the "law of prototypes," and a careful study of it enables pathologists to predict the various genera of tumours to which an organ may be liable, as well as to explain why primary epithelial tumours do not grow in bones and muscles, or myelomata and osteomata in the liver, kidney, or brain. It is important to indicate that although the tissues of an organ determine the species of tumours to which it is liable, their relative frequency can only be gathered from observation. It is also curious how organs vary in their liability to tumours; for instance, the heart is rarely occupied by a tumour, but the uterus, also a muscular organ, is with extreme frequency infested with fibroids; whilst voluntary (skeletal) muscles are rarely attacked by tumours of any kind, and they never arise from the true contractile tissue.

CLASSIFICATION.—Tumours form three groups:—

1. Connective-tissue tumours.
2. Epithelial tumours which comprise adenomata and cancers.
3. Dermoids.

Each group contains a certain number of genera, and each genus has one or more species; in describing the various genera care will be taken to define their structure, distribution, and clinical peculiarities, as well as the modes by which they may imperil life, because it must be borne in mind that a so-called innocent tumour may be as rapidly fatal as the most malignant tumour should it arise in, or involve a vital organ. This is a matter depending on environment, and will receive careful consideration with each genera.

GROUP 1.—CONNECTIVE-TISSUE TUMOURS

Genera.—1. Lipomata (fatty tumours). 2. Chondromata (cartilage tumours). 3. Osteomata (bony tumours). 4. Odontomes (tooth tumours). 5. Myelomata (marrow tumours). 6. Sarcomata. 7. Angeiomata (blood-vessel tumours). 8. Lymphangeiomata (tumours from lymphatics). 9. Myomata (muscle-tumours). 10. Neuromata (tumours connected with nerves and brain).

Lipomata.—These are tumours composed of fat. The genus contains a single species with a distribution as wide as the fatty or adipose tissue.

The common situation in which to find lipomata is the subcutaneous fat of the trunk and trunk-end of the limbs; they occur as encapsuled irregularly lobulated lumps of fat, more or less adherent to the skin. In the majority of instances one tumour is present, but as many as twenty or more may grow concurrently. A lipoma weighing sixteen ounces is a tumour of fair size, but it may attain twenty times this dimension. In many instances the very large tumours which have been reported as fatty were examples of molluscum fibrosum, and some examples in which they were particularly numerous, the disease was an example of general neuro-fibromatosis. Subcutaneous lipomata sometimes grow on the fingers, the palms, soles, and occasionally on the scalp. They have been known to exist on one individual for more than thirty years, and in a few exceptional instances the fibrous septa among the fatty lobules have calcified; in a few big tumours the fat has undergone saponification. The subcutaneous fat sometimes undergoes an irregular overgrowth, and forms what is known as *diffuse lipomata.* Precisely similar changes arise in the fatty stratum which underlies serous membranes such as the peritoneum and pleura. The fat beneath the serous covering of the intestines is occasionally the source of lipomata, which sometimes invade the muscular coat of the bowel and project into its lumen as a polypus. Such lipomata have, in a few instances, led to fatal intestinal obstruction.

The synovial membranes of joints possess a fatty layer, and lipomata occasionally arise therein and project as stalked bodies into the cavity of the joint.

Submucous tissue contains fat which serves as a source of lipomata. They have been found beneath the gastric mucous membrane, as well as in the lips, beneath the conjunctiva, and in the glosso-epiglottic folds.

Lipomata also arise in the adipose tissue between muscles, as well as in the belly of a muscle such as the biceps or the deltoid. Occasionally they spring from the sheath of nerves and the periosteum of bone. The connective tissue between the dura mater and the bony wall of the spinal canal contains fat, which has, in a few carefully recorded instances, furnished a lipoma; but probably one of the rarest situations in which a fatty tumour has been found, was between the layers of the dura mater lining the sella turcica. The patient, a woman forty-four years of age, suffered from periodical pain in the head and ptosis; the tumour was as big as a hen's egg.

Relation to Age.—Lipomata may arise at any age,—infancy, adolescence, and extreme old age. Occasionally they are congenital.

Clinical Characters.—The subcutaneous variety of fatty tumour rarely gives rise to difficulty in diagnosis, its intimate relation to the skin, doughy consistence, and the indefiniteness of its boundaries are very characteristic features. Lipomata in unusual situations often constitute clinical puzzles, especially when seated in or between muscles, or in the tongue; whilst those connected with periosteum often simulate sarcomata.

Lipomata never recur if completely removed. They are only dangerous to life when they arise in the cranium or spinal canal; or when they grow in the walls of the small intestine and protrude into its lumen and cause intussusception.

Chondromata.—This genus consists of tumours composed of hyaline cartilage. The most typical examples occur in long bones, and especially in relation with the epiphysial cartilages, hence the chondromata are more frequent in children and adolescents. They occur as distinctly encapsuled tumours, and often form deep cup-shaped hollows in the bone from which they grow. They are particularly liable to arise in the metacarpal, metatarsal, and phalangeal bones, and the frequency with which chondromata occur in the bones of those who were rickety in early life, had led to the suggestion that they probably arise in the untransformed islets of cartilage found in the immediate neighbourhood of rickety epiphysial cartilages. When multiple, chondromata rarely grow big, but a single chondroma in the head of the tabia or the mesethmoid will sometimes attain formidable proportions. Cartilage tumours may calcify and ossify; frequently they undergo mucoid softening.

Ecchondroses.—This is a species of chondroma which occur as small local overgrowths from the edges of articular cartilage, the cartilages of the larynx and the triangular cartilage of the nose.

Loose Cartilages.—This species of chondroma appears in the synovial cavity of joints, where they occur as pedunculated bodies hanging from the membrane, or loose in the joint. In many instances they are due to the chondrification of the synovial fringes; in others they are detached ecchondroses. A joint may contain one loose cartilage and the opposite joint is also occupied by one of similar size and shape. In rare instances, two hundred loose bodies have been found in one joint. Perhaps the most extraordinary situations in which chondromata arise are the parotid, submaxillary, and lacrimal glands. Here they violate all histological rules. This will be referred to when dealing with sarcomata.

Clinical Characters.—The usual situations for these tumours are the bones of the limbs in children and adolescents; they are distinctly circumscribed, and often so hard as to resemble osteomata. When they occur in the skull bones, then the diagnosis is difficult. They are only dangerous to life when they grow in the skull and compress the brain, or in a vertebra and squeeze the spinal cord.

Loose bodies in joints impair the utility of the limb and cause pain, but they are easily and safely removed.

Osteomata.—These are tumours composed of bone, and may be defined as ossifying chondromata, for every growing cancellous osteoma has a cap of hyaline cartilage which has the same relation to it that an epiphysis bears to a long bone.

This genus contains two species:—1. Compact osteoma. 2. Cancellous osteoma.

Compact osteomata are in structure identical with the hard tissue which forms the shaft of a long bone. They grow most commonly from the bones of the skull, especially in the neighbourhood of the external auditory meatus, the orbits, and from the angle of the mandible.

Cancellous osteomata grow from any bone and resemble the cancellous tissue of bone. They may be pedunculated or sessile. A single osteoma is the rule; often they occur in pairs and are bilaterally symmetrical. Multiple cartilage-tipped osteomata are occasionally met with in children; they are congenital, hereditary, and fairly symmetrical so far as position is concerned.

Clinical Characters.—Osteomata are easily recognised on account of their extreme hardness and in being localised to bones; they rarely cause pain except when growing in the vicinity of, and pressing upon the trunks of nerves. Osteomata near the external auditory meatus will occasionally induce deafness, and this becomes serious should the tumours be bilateral. An osteoma growing from the odontoid process has been known to fatally compress the spinal cord, and large osseous tumours of the facial bones will produce hideous deformity and occasionally destroy the eyeball.

It is a remarkable fact that occasionally in cases of congenital multiple osteomata, one of the cartilage covered tumours grows, disseminates, and destroys life like a sarcoma.

In clinical as well as in pathological writings care should be taken to keep a wide distinction between the—(*a*) ossification of tendons; (*b*) calcification of inflammatory exudations; and (*c*) the subungual exostosis. These are not true osteomata, but like cervical ribs, supra-condyloid ridges and third trochanters are often loosely classed as osteomata.

Odontomata.—These are tumours composed of dental tissues in varying proportions and different degrees of development, arising from teeth-germs or teeth in the process of growth.

This constitutes the most complete genus of tumours, and the various species are determined according to the part of the tooth-germ concerned in their formation. Those that arise from the enamel-organ in its early stages are soft and known as epithelial odontomes, whilst those which are known as follicular odontomes are due to aberrations of the follicle when the tooth is completed and ready to erupt.

Occasionally the follicle itself becomes converted into an encapsuled mass of fibrous tissue, in which a rudimentary or a badly formed tooth is embedded: this is a fibrous odontome and is, in some individuals, associated with rickety changes in the skeleton. When fibrous odontome ossify the hard tissue resembles cementum, and the tumour is called a cementoma. Sporadic dental changes in a fibrous odontome produce very curious results whereby the tumour contains numerous fragments of hard dental tissues—denticles; such are known as compound follicular odontomes. When the changes affect the roots of teeth after the crown is completed, the tumour is called a radicular odontome, and when it implicates the crown, neck, and roots, and produces an ill-formed lump of cementum, dentine, and enamel intermixed in an irregular way, it is called a composite odontome.

Clinical Characters.—The germ of any of the permanent teeth may become converted into an odontome, and occasionally two or more teeth may be involved in the same tumour. They occur with equal frequency in the upper and lower jaws, and the cystic species (follicular odontomes) may occur in multiples and attain great dimensions. Of the hard species the composite odontome is the most frequent, and in the maxilla such a tumour may invade the antrum and grow to the size of a hen's egg. Many of these large odontomes have been erroneously described as exostoses. In the mandible they rarely exceed the size of a dove's egg. A singular and important clinical fact in connection with the hard varieties is this: they rarely cause trouble until like teeth they begin to erupt, and this phenomenon generally happens between the twentieth and twenty-fifth years, and this draws attention to them. They are generally diagnosed as dead bone. In the past, operations unnecessarily severe have been undertaken for their relief.

Myelomata.—This genus consists of tumours composed of tissue identical in structure with the red marrow of young bone. These tumours were formerly classed as myeloid sarcomata, but they differ in many points from sarcomata, and above all things in the fact that they are not malignant.

A myeloma arises in the cancellous tissue of bone. When fresh its cut surface is deep red, and looks like a piece of fresh liver and is very vascular. Microscopically this tissue abounds in multinuclear cells (giant cells) embedded in round or spindle cells. The giant cells are so abundant as to constitute the greater proportion of the tumour. The distribution of the myelomata is that of red marrow, but they exhibit a striking preference for certain bones. In the lower limb the tibia, especially its head, is the most frequent situation, and the lower end of the radius is the common situation in the upper limb. In the head the body of the mandible has the preference. Myelomata have also been observed in the clavicle, humerus, and ulna, the femur and patella, and the jaws.

Clinical Characters.—Myelomata are rare tumours after the age of twenty-five. They grow slowly, and very gradually expand the bone immediately investing them, and occasionally it becomes so thin as to crackle on pressure. The soft tissue of the tumour sometimes perforates its capsule, and pulsates synchronously with the beat of the heart. These tumours do not infect lymph glands or disseminate; and if removed before the tumours perforate the capsules they do not recur. This fact is important in regard to treatment, for instead of amputating limbs to cure them, surgeons now excise the affected section of the bone whenever this is possible and leave the patients' useful limbs. Successful treatment of this kind has been carried out in the ulna, radius, humerus, clavicle, and even with the head of the tibia. Paget proved that some of the myelomata may be enucleated or scraped out of their capsules, and his example has in several instances been successfully followed.

Myelomata are rare tumours, and a careful perusal of the periodical literature of hospital reports shows that at each of the eleven large hospitals in London one myeloma a year is above the average.

Sarcomata.—The term sarcoma is applied to any connective-tissue tumour which exhibits malignant characters. It will therefore be useful to briefly describe the structure of these tumours, and then relate the manner in which they betray their malignity.

Sarcomata are named according to the prevailing type of the cells composing them; thus the round-celled kinds consist almost entirely of round cells, each possessing a large round nucleus which is always conspicuous in stained sections. There is very little intracellular substance; blood-vessels are abundant, but lymphatics are absent.

The round-celled sarcoma is the most generalised tumour that affects human beings; it occurs in bone, muscle, nerves, glandular, and muscular organs, ovary, testis, thymus, adrenal, and even in the delicate tissue of the retina. It may grow at any period of life, and even attacks the unborn child.

One variety of the round-celled sarcoma reproduces the delicate structure of a lymph gland. This is known as lymphosarcoma, and arises in definite situations where this peculiar tissue abounds, *e.g.* the tonsil, root of tongue, superior mediastinum, and the retro-peritoneal tissue.

The spindle-celled sarcomata are composed of cells resembling spindles, and though the individual cells of a tumour display extraordinary uniformity there is great diversity in the size of the cells in different tumours. In some the cells are small and oat-shaped, others are fusiform, or they may be extremely attenuated, and occasionally the cells are large and plump. In some situations spindle-celled sarcomata contain tracts of immature hyaline cartilage, these are termed chondrifying sarcomata. But the most extraordinary feature found in these tumours is the occasional occurrence of spindles with a transverse striation like that which is met with in the young muscle cells. These are known as myosarcomata, and are found in the most unexpected situations, such as the testis, sinus of the kidney, and the neck of the uterus, where muscle cells of the striped variety do not occur under normal conditions.

The presence of hyaline cartilage in sarcomata of secreting glands like the parotid and the mamma, and the occurrence of tissue indistinguishable from striated muscle tissue in the testis and kidney, and also in lipomata of the periosteum and in the spinal canal has never received an adequate explanation, although it has thoroughly aroused the curiosity of pathologists and led to much unsound speculation.

One of the most striking species of the sarcomata is that to which the adjective melanotic is applied on account of its blackness. This is due to the presence of a pigment called melanin. The meláno-sarcomata may consist of spindle or round cells, and always arise from pigmented tracts of skin, and especially the black moles and congenital pigmented warts; but the common situation is the uveal tract of the eyeball. The colour of melano-sarcomata vary greatly, some only contain faint traces of pigment, whereas others are inky black.

There is probably nothing more remarkable in the whole of Oncology than these pigmented tumours; an individual may have an area of the skin less than an inch square occupied by a black mole which was present at birth. This has never caused any inconvenience, and then when he has arrived at the age of fifty or perhaps seventy it begins to enlarge, it may even pulsate; then the adjacent lymph glands are noticed to be enlarging, and in a few months he has melanotic nodules in skin, lungs, liver, and other organs, and daily discharges large quantities of the pigment melanin in the urine. Of the cause of this mysterious condition nothing—absolutely nothing is known. There is an excessively rare variety of melanotic tumour which occurs in the eyeball, arising from the ciliary glands detected by Treacher Collins. It has the characters of a typical carcinoma.

Melano-sarcomata illustrate, too, a fact in connection with the tissue prototypes of tumours. The connective tissue underlying a mole has a characteristic alveolar arrangement, and this is also manifested in many of the tumours, and by some writers has been made into a separate species as alveolar sarcoma.

Sarcomata are distinguished from the other chief genera of connective-tissue tumours in that they rarely possess capsules, and when they do it is generally a spurious encapsulation depending on environment, such as when they arise in the eyeball, medullary cavity of a bone, or in the sinus of the kidney. Having no restraining capsule they are able to infiltrate the adjacent tissues.

The vascularity of sarcomata varies; in all the circulation is mainly capillary and the very soft, quickly growing and badly organised round-celled species often have such an abundant supply of arterial blood that they distinctly pulsate.

Sarcomata of the spindle-celled kind grow slowly, and are not so rich in blood-vessels; but all the species lack lymphatics. The intimate relation of sarcomata to the blood-vessels has an important relation to the distribution of sarcoma cells to other parts of the body; for example, the cells from the tumour find their way into the venules which return the blood into the venous trunks and are directly conveyed as minute emboli to the lungs; these cells are arrested in the pulmonary capillaries and they act as grafts, retain their vitality, and form what is known as secondary nodules or deposits. There is no limit to the number of these secondary deposits, and a hundred or more may be counted in the lungs. When the primary sarcoma is situated in a part from which the venous blood enters the portal circulation the emigrant cells from the tumour are received by the capillaries of the liver, and thus the secondary nodules are found in the territory of the portal circulation and especially in the liver. This remarkable phenomenon is known as dissemination, and it is one of the most dangerous features displayed by malignant tumours.

The fact that sarcomata are usually unencapsuled allows the cells of the tumour to permeate or infiltrate the adjacent tissues, and this peculiarity becomes extremely dangerous when the sarcoma arises in the midst of important structures. Thus in the mediastinum an infiltrating tumour may involve the œsophagus, trachea, lung, pneumogastric nerves, pleura, pericardium, vena cava on the aorta. A sarcoma of the kidney is very liable to creep into the renal vein, and a prolongation of the tumour will extend into the inferior vena cava; a sarcoma of the thyroid gland may open into the trachea or the internal jugular vein.

This infiltrating property of a sarcoma, apart from its effect upon neighbouring organs, has an important bearing on treatment. For example, when the surgeon attempts to remove a sarcoma effectually it is of the utmost importance to cut well wide of it, for if small portions of the tumour are left the sarcoma grows again from these remnants. When the tumour returns in this way it is spoken of as recurrence, and this is a common mode by which sarcomata manifest malignancy. There are few things which demonstrate the deadly nature of some of these tumours better than a sarcoma springing from the periosteum of the femur. A youth will present himself with one of these tumours in the lower end of this bone, and it may be about the size of a goose's egg. The limb is amputated at the hip joint, and in a few months the sarcoma reappears in the stump and grows in a few months into a large bleeding mass and quickly destroys him. It is not an uncommon event for a sarcoma to appear in connection with the femur or the humerus and destroy life either by dissemination, or by recurrence after operation within a year of its detection.

Although sarcomata as a genus are ubiquitous, nevertheless they occur in some situations more frequently than in others, and present some striking age-relations that are worth careful study.

Take for example the eyeball: this sense organ is liable to two very distinct kinds of sarcoma. Before the age of twelve years, sarcomata arise in the retina and possess the minute structure of the sustentacular framework of the retina as it exists in the embryo. These tumours often attack both retinæ, and though they rarely disseminate they are extremely prone to recur after removal of the eyeball. The adult is liable to sarcomata which arise in the uveal tract, and is almost invariably of the pigmented (melanotic) species. It is always unilateral, and though it is not so liable to recur locally as retina sarcoma, it is dreadfully liable to disseminate and infect almost every organ in the body, and occasionally to dye the whole skin black. The proneness with which sarcoma attacks bilateral organs during infancy and childhood is somewhat remarkable, and is especially manifest in the retinæ, kidneys, ovaries, and adrenals. In quite a large number of instances sarcoma attacking these organs during infancy may be limited to one gland, but in a fair proportion of cases both are affected. This bilateral disposition is not seen when sarcoma arises in these parts in adults; not only is the disease unilateral, but it exhibits, as has already been stated in regard to the eyeball, diversity in its minute structure.

The variations in the liability of different organs to sarcomata is not greater than the variations observed among organs of similar structure and functions. Take for instance the salivary glands. Sarcoma of the parotid gland is quite common: it is rarely seen in the submaxillary and lachrymal glands, and is equally rare in the pancreas.

Sarcomata occur far more frequently in the structures of the lower limb than in those of the upper. This is certainly the case in regard to bones. Sarcomata are rare in voluntary muscles and in nerve-trunks, and the majority of the recorded cases, excluding the optic nerve, have been observed in the muscles and nerves of the lower limb.

The ovaries and the uterus are organs closely associated in functions, but sarcomata are frequent in the ovaries but unusual in the uterus.

Lastly, there is the important question, can an innocent connective-tissue tumour change its character and become malignant? In the majority of instances the facts indicate the insufficiency of our means of distinction rather than an actual metamorphosis of tissue.

A long study of the histogenesis of tumours has convinced the writer that the clearly innocent and the decidedly malignant tumours present distinct histological features, but there are intermediate varieties which cannot be sharply defined in relation to these points, and this comes out in a very striking and suggestive way when an individual possesses supposed innocent tumours in multiples. For example, take uterine fibroids when they are multiple, tumours may be selected from one uterus of which some are so hard as to need a saw to divide them and others so soft as to be almost diffluent, such myxomatous tumours will recur after enucleation: and careful records are accessible in which fibroids of simple structure have disseminated and destroyed life. This is true of multiple and hereditary cartilage-clad osteomata; and also true of the nodular form of molluscum fibrosum.

It is so difficult to decide between the slow growing spindle-celled sarcomata, the fibrifying sarcoma, and the gelatinous myxoma, that it is safer to include myxomata and the hard tumours called fibromata with the sarcomata until distinctive methods have been detected by the histological chemist, biologist, or the bacteriologist.

These difficulties are further exemplified by the peculiar but excessively rare disease known as *chloroma* or green cancer, in which sarcoma-like masses form on the bones of the skull and face, especially in the neighbourhood of the orbits, and secondarily infect other organs. After death the colour of the tumour-like masses is, on section, grass green. The nature of the disease is excessively obscure: some writers regard it as a form of leukæmia. It has lately been carefully studied by Melville Dunlop (*British Medical Journal,* 1902, vol. i. p. 1072).

Angeiomata.—These are tumours composed of an abnormal formation of blood-vessels. The genus contains three species: 1. Simple nævus. 2. Cavernous nævus. 3. Plexiform angeioma. The simple nævus is of very common occurrence and appears in the skin or mucous membrane as a patch of discoloration, which may be pink or deep blue. When the nævus is due to aberrations of venules it will be blue, but when arterioles preponderate it will be pink. The vessels of the nævus are embedded in fat, and a few lymphatics are also present. Nævi vary in size, some are scarcely perceptible, whilst others may involve the skin of half the trunk or a whole limb. They may occur in multiples and in any part of the skin, lips, labia, conjunctivæ, or tongue. Small nævi tend to disappear, some remain stationary and a few become converted into cavernous nævi. These are sometimes called erectile tumours, because they structurally resemble the cavernous tissue of the penis. These tumours are common in the skin, and they have been observed in the rectum, subperitoneal tissue, liver, bladder, the larynx, wall of the right auricle of the heart, and in voluntary muscles such as the deltoid, the semimembranosus and the gracilis.

The plexiform angeioma or "aneurysm by anastomosis" consists of a number of abnormal blood-vessels of moderate size arranged parallel to each other, as in the retia mirabilia in the fore-limbs of sloths. Some of the plexiform angeiomata consist of arteries only, others of veins and arteries. Often the vessels are very tortuous. Fortunately this species of angeioma is rare: it has been observed on the scalp, forearm, and in the perineum surrounding the urethra.

All angeiomata are congenital, or arise in the first few weeks after birth; it is instructive to watch a small red fleck, at first no larger than a split pea, slowly spread and then begin to stand above the level of the skin: a few months later it may form a raised oval pulsating lump, which may be red or blue, and at last become a tumour demanding some courage as well as skill on the part of the surgeon to deal with it. Occasionally a simple nævus will be converted into a cavernous nævus, and the central parts of the latter fuse and form a central space so that the tumour resembles a cyst with very vascular walls. Such have been called nævoid cysts.

Lymphangeiomata.—These are tumours composed of an abnormal formation of lymphatics. They bear the same relation to lymph vessels that angeiomata bear to the hæmic capillaries. This genus contains three species: 1. Lymphatic nævus. 2. Cavernous lymphangeioma. 3. Lymphatic cyst.

The lymphatic nævus is, as a rule, colourless, but as it contains hæmic capillaries it may be of a pale pink. In the tongue the lymphatic nævus is sometimes of a faint yellow or serum colour. Sometimes a lymphatic nævus will affect a tract of mucous membrane like that of the tongue and produce the condition known as macroglossia, or it may affect the lips and cause macrochelia. Cavernous lymphangeioma resembles in structure and distribution the cavernous nævi, and differs from them only in containing lymph instead of blood.

Lymphatic cysts have been described under a variety of names, and the most familiar examples are those known as "hydrocele of the neck." They appear as congenital translucent cystic swellings, and though most common in the neck, are also found in the axilla and on the anterior and posterior wall of the thorax. These cysts are filled with lymph and the walls are composed of very vascular nævoid material. The most remarkable fact in connection with them is the great tendency they exhibit to shrivel and disappear. They are very prone to inflame, and this event generally precedes their disappearance. In some of the instances it has been recorded that "the cyst was burst by the child falling upon it," and the accident led to its cure. The proneness of lymphatic cysts to spontaneous cure explains their rarity after puberty; this is fortunate, for their treatment by surgical means is uncertain and often extremely dangerous.

Endothelioma.—This is a rare species of tumour, which is supposed to arise from the inner walls of blood and lymph vessels. The tumours rarely attain a large size, but are excessively prone to degenerate, and they also exhibit malignant characters, which are displayed more especially in the form of local recurrence.

Endotheliomata have been described in relation with the mucous membrane of the jaws (gum), palate, in the skin, especially in connection with moles and warts: also growing from the pleura.

It is probable that many tumours described as epithelioma of the gums and palate, and some remarkable malignant tumours described as cystic disease of the jaws, were endotheliomata.

The peculiar tumours (often called sarcomata) of the parotid and occasionally of the submaxillary glands are probably of this nature, and it is known that lymphatics abound in these organs. The tumours themselves are remarkable for the variety of tissues they contain, as well as for their curious clinical features.

It is also necessary to mention that there exist good grounds for the belief that tumours allied to the sarcomata also arise from the walls of blood-vessels, and in many respects behave like the endotheliomata.

Myomata.—These are tumours composed of unstriped muscle tissue. They are met with exclusively in organs containing this tissue, *e.g.*, the œsophagus, stomach, and bladder, but in these situations they are extremely rare. The common situation is the uterus, where they are known as fibroids. It was formerly supposed that these tumours were composed of fibrous tissue, until Virchow demonstrated that they consist mainly of unstriped muscle tissue.

The fibroid or fibro-myoma may arise in any part of the uterus, but are more common in the body and fundus than in the neck of this organ. The tumours are always encapsuled; they vary very much in density, some are soft and gelatinous, others are as firm as cartilage, and some undergo calcification and resemble porous stone. That these are varieties of the same tumour is shown by the fact that the different kinds of fibroids may be found in the same uterus, and not infrequently the gelatinous, the firm and the calcified tissues may be found in the same tumour.

A uterus may contain one large fibroid or it may be occupied by ten or more. The writer has met with one remarkable uterus which contained one hundred and twenty fibroids; they varied in size from a mustard seed to a dove's egg.

Clinical Characters.—Fibroids are only met with after puberty, and are extremely rare before the age of twenty-five; from the thirtieth to the forty-fifth year they become very common, and it is probable that they never arise after the termination of menstruation.

Fibroids are inimical to health and dangerous to life in a variety of ways: they cause under certain conditions profuse and even fatal bleeding; they are apt to become infected and destroy life from septicæmia. Very rarely they become sarcomatous and disseminate. Very large tumours fill up the pelvis and interfere with the bladder, and thus set up changes in the kidneys. In many instances they coexist with pregnancy, and may obstruct the transit of the child or even prevent the pregnancy going to term. In some individuals the stalk of a pedunculated fibroid will entangle a coil of bowel and produce fatal intestinal obstruction, or an impacted fibroid will press on the rectum and lead to the same result. In very many instances a woman may have many fibroids in her uterus and never suffer the least inconvenience.

Neuromata and Neuro-fibromatosis.—The tumours of nerves formerly grouped together as neuromata by surgeons have never satisfied pathologists, but in recent years a large amount of careful investigation has been conducted into the histology of certain lesions of nerves and skin, which enable some remarkable and apparently diverse conditions to be included under the heading neuromata.

The nerve centres, brain and spinal cord; the nerve trunks and their terminal twigs; the sympathetic nerve cords and their ganglia are all pervaded with connective tissue of varying degree of texture, for instance, it is coarse in the great sciatic nerve but of extreme delicacy in the retina and brain, where it is known as neuroglia.

The common and familiar swelling to which the term neuroma is usually applied is an ovoid encapsuled tumour composed of tissue identical with that of the nerve sheath. These tumours may occur singly or in multiples upon any nerve or nerve roots. Some of them are no bigger than cherry stones; when one grows on the terminal twig of a cutaneous nerve it gives rise to such pain when touched that it is called in consequence a "painful subcutaneous tubercle." The common solitary neuroma has received a variety of names, depending on its minute structure, such as myxoma, myxo-fibroma, fibroma, and so on, the varieties of texture being due to degenerative changes in the tissue of the tumour. It has, however, been definitely proved that multiple tumours sometimes form in the skin and resemble lipomata, but on careful examination they have been found to contain nerve elements, and particularly nerve cells. These are known as ganglionic neuromata, and it is supposed that they arise on the terminal twigs of the sympathetic nerves distributed to the cutaneous branches of arteries.

It has been known for many years that individuals occasionally come under observation with tracts of skin excessively developed in the form of overlapping folds, and these may form on the trunk, head, or limbs. This condition is known under a variety of names, but that accepted by the most recent writers is molluscum fibrosum. This disease may also manifest itself in the form of a multitude of discrete nodules in the skin, varying in size from a mustard seed to a billiard ball. Recklinghausen, who studied the histology of these molluscum nodules with great care, has expressed the opinion that they arise from the terminal twigs of cutaneous nerves. These molluscum nodules occasionally occur in individuals who have also a multitude of irregular swellings on their nerves, and in one remarkable instance two thousand tumours were observed on the skin and nerve trunks of one man. It is also an important fact that though neuromata, molluscum nodules, and molluscous folds usually occur separately in individuals, nevertheless the three conditions are sometimes met with in the same patient.

It is now usual to speak of the generalised form of the disease as neuro-fibromatosis, and an important feature connected with the extreme forms of the disease is the liability of the patients to sarcoma; this may develop primarily, or arise as a malignant change in a molluscum nodule which has existed many years. In some cases of generalised neuro-fibromatosis the patients die from gradual exhaustion due to ulceration or septic changes in the large pendulous folds of skin.

Pathologists have long been familiar with a peculiar overgrowth of the delicate connective tissue of the brain and spinal cord under the name of glioma; this appears as a translucent swelling imperfectly demarcated from the surrounding tissue and, as a rule, this gliomatous tissue has little more consistency than vitreous humour; microscopically it has all the characters of neuroglia. Virchow points out that when a glioma is situated near the surface of the brain it appears like a colossal convolution, and when it attacks an optic thalamus this structure bulges into the third ventricle as though overgrown; and occasionally the disease attacks the cerebral crura in children under twelve years of age, and produces peculiar enlargement of this part of the brain.

It is an extraordinary fact that the connective tissue, especially the endoneurium of nerves, is liable to a similar change, this may be, and usually is, limited to a particular nerve and its branches, *e.g.* the anterior crural, the musculo-spiral, or the great occipital. The effect is very striking, for the nerves become thickened, elongated, and tortuous, and when cut across the nerve sheath is found filled with gelatinous tissue and produces an appearance not unlike the cut surface of an umbilical cord. Microscopic examination of the enlarged nerve reveals the axis cylinders embedded in overgrown endoneurium. To this condition the term plexiform neuroma is applied, and it is necessary to mention not only that the disease is congenital, but that the nerves most affected are often covered by pigmented skin; frequently the overlying skin is in the condition known as a hairy mole.

The plexiform neuroma is not only allied to gliomata by the peculiar changes of its endoneurium, but its pathological relationship to molluscum fibrosum and localised neuromata is demonstrated by the occurrence of a plexiform neuroma beneath a molluscum fold; and a large oval neuroma may form on a nerve, the sheath of which is thickened throughout. There are also good grounds for the inclusion of retinal glioma in this group, for the optic nerve and retina are processes of the brain, and the parallel exhibited in the age distribution of the gliomatous enlargement of the pons and crura met with in children under twelve years of age and the limitation of glioma of the retina to infancy are significant features. The malignancy of retinal glioma has its parallel also in the occasional occurrence of sarcoma in a molluscum nodule.

Group 2.—The Epithelial Group

In the tumours of this group the epithelium is not only present but is the essential and distinguishing feature. The difference in the disposition of the epithelium enables the tumours to be arranged in three genera: 1. Papillomata; 2. Adenoma; and 3. Carcinomata (cancer).

1. *Papillomata.*—These are commonly known as warts, and may arise on any surface covered with epithelium. Structurally a wart consists of an axis of fibrous tissue containing blood-vessels, surmounted by epithelium. The wart may be simple and present a uniform surface, or be so covered with secondary processes as to look like a mulberry. When the warts grow from a surface covered with stratified epithelium the cells on the warts have the same disposition; this is seen when they arise on the skin or the mucous membrane of the larynx. When they grow from the mucous membrane of the bladder or the pelvis of the kidney warts have an appearance not unlike chorionic villi, and are termed in consequence villous papillomata; this species is very delicate and extremely vascular. A rare but important form of papillomata grows from the choroid plexuses of the cerebral ventricles, and are apt to become calcified and form a tumour composed of peculiar concentric bodies. These tumours are known as psammomata. Villous papillomata are apt to grow in cysts, which arise in dilatations of the milk ducts of the mammary gland; these are known as intra-cystic papillomata, but the most remarkable examples of this species arise in certain ovarian cysts, where they form dendritic masses which burst the cyst wall, and then sprouting into the abdomen resemble a large cauliflower.

Warts are under certain conditions inimical to life. Thus the large solitary congenital pigmented wart is apt to be the starting-point of a melanoma. Warts in the larynx sometimes induce suffocation. Villous papillomata of the fourth ventricle give rise to fatal pressure on the important nerve centres on the floor of that cavity, and the vascular villous tumours of the bladder and kidney occasionally cause death from oft-recurring bleeding.

An important change to which skin warts are liable is the slow conversion of the surface cells into horn. Such horns may attain a length of 9 inches.

Adenomata.—These are tumours constructed upon the type of and growing in connection with secreting glands. They occur as encapsuled tumours in such organs as the mamma and liver; and in glands like the parotid and thyroid. When they arise in the mucous membrane of the rectum, intestine, or uterus they are pedunculated (or polypoid). A single adenoma may arise in a gland, but it is not uncommon for them to occur in multiples. In size they vary greatly, some are no bigger than peas, whereas an adenoma in the mammary or the thyroid gland may form a tumour, as big as a man's head. An adenoma contains glandular spaces, and though a tumour of this kind does not furnish the secretion peculiar to the gland in which it arises, it nevertheless produces in many instances a perverted secretion which leads to great distension of the spaces in the tumour, and converts it into a cystic body. Tumours of this kind occurring in the breast are sometimes termed "adenoceles," and in the thyroid gland bronchoceles. Some of the largest occur in the ovary (ovarian adenomata), and sometimes attain a weight of a hundred or more pounds. The effects of adenomata depend in the main on the situations in which they grow. For example, a very large mammary adenoma may be, and usually is, painless, but it annoys by dragging on the parts and disfigures by its size, whereas a small adenoma of the prostate gland may so thoroughly plug the vesical orifice of the urethra as to produce complete obstruction to the flow of urine. So too in the thyroid gland, a bronchocele may be so big that the patient has to support it with her hands whilst she walks about, and yet it does not endanger life, whilst a solid adenoma no bigger than a walnut may compress the trachea and induce fatal dyspnœa.

The following statements are true of all adenomata: when completely removed there is no fear of recurrence; they do not infect lymph glands; nor give rise to secondary deposits.

A tumour in many points closely allied to adenomata is that known as the sebaceous cyst, so common in the skin and particularly of the scalp. These tumours arise in the sebaceous glands. They may occur singly or in multiples. Sebaceous cysts may inflame, suppurate, or form cutaneous horns.

Carcinoma (cancer).—The term carcinoma is applied to a malignant tumour arising in epithelium. When the source of the cancer is the epithelium of a secreting gland, it is described as a glandular carcinoma, but when it arises from a surface covered with squamous epithelial cells, it is called squamous-celled cancer, or more particularly by British writers epithelioma.

The microscopic structure of a cancer is very simple, for it consists of columns of cells, so that when these columns are cut at right angles the section has the appearance of a number of alveolar spaces filled with epithelium. The walls of these alveoli consist of fibrous tissue of varying degrees of density in different species of cancer, and in this tissue the blood and lymph vessels ramify. These cell-columns are not always simple but branch and ramify in different directions, producing in some sections very complicated appearances. The softness or hardness of a cancer depends in a large measure on the amount of cells as well as on the density of the fibrous tissue composing the septa. The cells in the columns take their characters from the cells in which the cancer arose, and so constantly do they preserve the type of the cells, and so frequently mimic the architecture of the gland in which the cancer is situated, that an experienced histologist can often determine the source of the carcinoma from a study of its microscopic features.

Although cancer may arise in any epithelial covered surface or secreting gland it is exceedingly common in some and very rare in others. Thus the three commonest situations are the mammary gland, the stomach, and the neck of the uterus; it is rare as a primary tumour in the liver, the thyroid gland, and the kidney, and it is a significant fact that it is more prone to arise in glandular organs which have been injured, or are the seat of chronic disease, than in those that are healthy: this is borne out especially in the case of cancer arising in the neck of the uterus, for this disease is almost exclusively confined to women who have been pregnant, and in the thyroid gland, for cancer of this gland is much more frequent in countries where goitre is endemic.

A striking feature of cancer is the fact that it is not circumscribed, and it is not possible in naked-eye examination to define the limits between the tumour and the surrounding tissue: this indefiniteness is more obvious when in the course of an operation the surgeon cuts into it, and when the parts are subjected to microscopic scrutiny it is difficult to determine with accuracy the limits of the cancerous territory.

It is this illimitation which constitutes one of the greatest difficulties in dealing with cancer surgically, and has led surgeons to advocate the complete extirpation of cancerous organs whenever possible with the hope of eradicating the disease. When cancer extends beyond the organ in which it arises, the cancerous elements will quickly involve, or implicate, adjacent organs, whether they consist of skin, fat, muscle, or bone. This tendency to implicate neighbouring organs is a grave feature of this disease, and is a common cause of death, as well as being a bar to efficient operative efforts.

A very dangerous character of cancer is the frequency with which it infects lymph glands. All epithelial structures are rich in lymphatics, and these convey the cancer elements to the lymph glands associated with the cancerous part; and such infected lymph glands may form a tumour far exceeding in size the primary cancer. It is a difficult matter to determine in a given case the extent to which the lymph glands have been infected, and this adds to the uncertainty in estimating the value of surgical interference.

Cancers are exceptionally prone to disseminate, and secondary growths may make their appearance in any organ or tissue and, not infrequently, in bone. The cancerous particles that give rise to these secondary nodules are transported by lymph and blood-vessels, and when these minute cancer-emboli are lodged in suitable situations they multiply and give rise to nodules which in their histologic features exactly resemble the parent tumour. The amount of dissemination varies greatly: in some cases secondary growths may be only found in the liver or lung, yet in another and apparently identical case, so far as the structure and situation of the tumour are concerned, secondary knots appear in almost every organ including the skeleton.

The vitality and power of independent growth possessed by minute detached portions of cancer is extremely remarkable. These minute epithelial emigrants not only live and grow but they reproduce the peculiarity of the primary tumour. It is astonishing to find a secondary mass of cancer in the humerus with all the characters of the glands of the rectum; nodules on the lungs exactly reproducing that peculiar form of hepatic cancer that arises in the biliary ducts; or the familiar closed follicles of the thyroid gland reproduced in the spinous process of a vertebra; or a nodule with the structure of a mammary cancer growing in the choroid coat of the eye.

This great power of independent growth possessed by cancerous epithelium is a very dangerous feature, and it occasionally happens that in the course of operations cancerous elements are spread about the wound and give rise to a form of rapid local recurrence which accelerates the fatal course of the disease.

The Cause of Cancer.—There are many facts which indicate that cancer is induced by micro-parasites, for those glands which are direct communications with the air or intestinal gases are most prone to become cancerous, *e.g.* the mamma, rectum, and stomach; whereas cancer of the thyroid and prostate is unusual.

The great frequency of cancer in the cervical endometrium, in comparison with its infrequency in the corporeal endometrium, and its extreme rarity in the mucous membrane of the Fallopian tubes are significant facts in relation to invasion by micro-parasites. The greatest difficulty in connection with the micro-parasitic or infective theory as to the origin of cancer is the extraordinary fact that the secondary nodules are structurally identical with the primary tumour independently of the tissue in which they are deposited. This is quite contrary to the behaviour of disseminated foci in such typical micro-parasitic diseases as glanders and tuberculosis. It is possible that in cancer the cell-emboli with the micro-parasite when lodged in foreign tissue multiply in virtue of the presence of the parasite. However, the latter is as yet purely hypothetical.

It has already been mentioned that the frequency with which cancer attacks secreting glands varies greatly. In some it is fearfully common, in others extremely rare, and in a few almost unknown. Although lymph gland infection and dissemination occur in all forms, nevertheless there is great variation: for example lymph gland infection is a most common and striking feature of squamous-celled cancer (epithelioma), especially when it occurs near the mouth, anus, or on the scrotum, and dissemination is the exception. Yet in the peculiar form of cancer which attacks the face (rodent ulcer) lymph gland infection is a very rare phenomenon and dissemination unknown. In mammary cancer the lymph glands are early infected and wide dissemination is the rule. In cancer of the neck of the uterus, enlarged lymph glands and dissemination only occur in the late stages of the disease.

The situation of secondary nodules can with a fair measure of success be foretold. Thus in mammary cancer it is the lungs which are most commonly infected: when the intestine is the seat of the primary disease the liver becomes the repository of the secondary nodules, and when the cancer erodes its way into a serous cavity it may directly infect it. This is seen when the primary disease is in the ovary, intestine, or gall-bladder.

It is an unexplained fact that some organs though frequently occupied by secondary deposits are rarely attacked primarily, this is true especially of the lung and liver.

Cancer, though structurally the same in all the situations in which it occurs, and exhibits all the dangerous features of this disease in regard to infection and dissemination, nevertheless displays great variation in its effects according to the secreting gland in which it arises. All these peculiarities, as well as the variations in age-liability, modes of death, and the results which follow surgical interference will be most appropriately dealt with in the articles devoted to the particular consideration of each organ.

GROUP 3.—DERMOIDS

These are tumours furnished with skin or mucous membrane occurring in situations where these structures are not found under normal conditions. They only possess tissues which naturally belong to skin or mucous membrane. Dermoids may be arranged in four genera:—1. Sequestration Dermoids; 2. Tubulo-dermoids; 3. Dermoid patches (moles); and 4. Ovarian Dermoids.

1. *Sequestration Dermoids.*—These arise in detached or sequestrated portions of skin chiefly in situations where, during embryonic life, coalescence takes place between cutaneous surfaces. Thus they are met with in the middle line of the back; in the scrotum; in the middle line of the sternum, and more especially in the situation of the facial fissures. They also occur frequently on the scalp. As a rule they do not exceed the dimensions of a tangerine orange, but occasionally they attain the size of a cocoa-nut. They are congenital, and consist of a central cavity lined with skin furnished with hair and the cutaneous appendages met with in the normal

skin adjacent to the dermoid. As a rule a sequestration dermoid is not inimical to life. Occasionally, however, a dermoid in connection with the cranial dura mater will lead to fatal intracranial pressure, and a dermoid of the spinal dura mater has produced death from paraplegia. A dermoid arising from the internal aspect of the chest-wall will interfere with the lung, and if air gain access to it will simulate an empyema complicated with what is known as "hair-spitting."

2. *Tubulo-Dermoids.*—This species arises in connection with what are known as obsolete canals, *e.g.* the branchial clefts, the post-anal gut, and the thyro-glossal duct. Dermoids arising in the neck in relation with the anterior border of the sterno-mastoid muscle have long been associated with the branchial clefts. On the other hand, tumours of this character occupying the floor of the mouth or situated between the genio-hyo-glossi muscles have been many times observed, but were described as sebaceous cysts. A more thorough examination of their structure, aided by a better knowledge of the details of the development of the tongue and mouth, has proved that they are dermoids; and that many of them arise in the glossal segment of the temporary passage between the tongue and the embryonic thyroid gland, known as the thyro-glossal duct.

Post-Rectal Dermoids are by many associated with the extension of the primary gut which, in the embryo, extends behind the anus, and which for a time is in communication with the central canal of the spinal cord by means of the neurenteric canal. The best examples of dermoids arising in the post-anal gut are always congenital, and generally of large size, and contain gland spaces and sometimes well-formed Lieberkühnian follicles. Another variety is situated between the rectum and the sacrum; some of these are undoubtedly teratomata. A third and rarer variety takes the form of a pedunculated skin-covered pilose tumour hanging from the mucous membrane of the rectum.

3. *Moles* (*Dermoid Patches*).—Moles are pigmented and usually hairy patches growing on the skin. They are congenital, or appear during the first few weeks after birth. These patches vary greatly in size; many are no bigger than split peas, whilst others cover an extensive area on the face, trunk, the limbs, and even on the scalp.

The common variety consists of a slightly raised brown patch, it is sometimes quite black, and is as a rule pilose, the hair being short. The hairs are furnished with sebaceous glands, and the skin often contains sweat-glands even when the mole is situated on the conjunctiva. The most striking feature in the histology of a mole is the fact that the tissue immediately underlying it is arranged in alveoli, like that described as characteristic of an alveolar sarcoma. Moles bleed freely when their surfaces are abraided, they are liable to ulcerate, and later in life are occasionally the sources of melano-sarcomata. They occur singly or in multiple, as many as fifty may occur on one individual; sometimes one mole may be so big as to cover half the trunk. Moles on the conjunctiva are often associated with defects in the eyelids, such as coloboma and total absence of the lids.

Ovarian Dermoids.—Cystic tumours containing skin and often furnished with the appendages of skin, such as hair, sebaceous and sweat-glands, teeth, horn, and bone, occur with exceptional frequency in the ovary. In rare instances a mammary gland furnished with a nipple and areola has been met with, and also an organ which in structure resembled a thyroid gland. Many of the loculi in ovarian dermoids are lined with mucous membrane. These tumours may be unilocular or multilocular, and when the skin elements predominate the cavities are filled with a mixture of fat, sebum, shed hair, teeth, etc. When the loculus contains mucous membrane, then the cavity is filled with mucus of the consistence of thin jelly. In size ovarian dermoids vary greatly, some are no bigger than an orange, whilst others attain a weight of twenty or forty kilogrammes. The average dimensions of these tumours is that of a cocoa-nut. They occur at all periods of life, and have been met with in a child a year old and in a woman of eighty-three. There is no authentic observation of a dermoid in a new-born child.

Some extraordinary theories have been advanced to account for these tumours in the ovaries, such as pathogenesis and imperfect conceptions, etc., but very careful histological investigations of small specimens have shown that these tumours arise in that portion of the ovary in which the ova are lodged (the oöphoron), and that the epithelial lining of the ovarian follicles is the source of the structures found in ovarian dermoids.

These tumours are dangerous to life in a variety of ways, for they may lead to intestinal obstruction, they may offer a great and sometimes an impassable obstruction to the birth of a child, or they inflame and suppurate. Occasionally from its mere bulk an ovarian dermoid will interfere with the diaphragm, and compress the lung, death being due to interference with respiration.

They are innocent tumours, and when removed have never been known to recur. Ovarian dermoids are often bilateral. Occasionally they burst into the general peritoneal cavity, and the epithelium may engraft itself on the peritoneum and form tiny dermoids. This phenomenon may be conveniently termed "epithelial infection."

Teratomata.—Strictly the consideration of teratomata belongs to the department of pathology known as Teratology, but some teratomata are very apt to be confounded with dermoids. In the majority of the specimens there is no difficulty, because a teratoma is an irregular conglomerate mass containing the tissues and segments of viscera of a suppressed fœtus attached to an otherwise normal individual. Tumours of this character are common in the neighbourhood of the sacrum, and are known as one variety of the congenital sacro-coccygeal tumour; they also occur around the cephalic termination of the notochord, and appear in the pituitary fossa or in the pharynx, either as sessile or pedunculated tumours. The rarest form of teratoma occurs as a retroperitoneal tumour. The variety of teratoma which it is most difficult to distinguish from a dermoid is that which appears as a skin covered tumour in the nasopharynx or between the rectum and coccyx.

All sequestration dermoids and all teratomata are congenital, but no one has observed a congenital ovarian dermoid, and this is a distinguishing feature of great significance in considering the pathology and pathogenesis of dermoids.

PHANTOM TUMOUR.—This term is applied to a tumour which appears and disappears without any obvious reason. In the limbs a phantom tumour assumes the form of a smooth, uniform, resistent swelling; it is generally painless, and usually subsides during sleep, to reappear when the patient wakes, but it always vanishes under deep anæsthesia. Phantom tumours occur in men, but they are commoner in women, in whom they assume the curious form of mimicry known as "spurious pregnancy" or pseudocyesis, but it simulates ovarian and other abdominal swellings as well as pregnancy.

The symptoms of this form of phantom tumour are briefly these: a woman will fancy she is pregnant or suffering from a tumour, and states that her abdomen has been gradually increasing in size.

These cases rarely give rise to difficulty. When the abdomen is submitted to physical examination, it will be found everywhere resonant, and loud intestinal gurgling is usually present; by cautiously engaging the patient in conversation during the manipulation, the belly may be pressed quite flat. In such a case the age gives important indications, especially when the woman has passed the menopause. Again, in younger women, the other signs of pregnancy, such as enlargement of the breasts, morning sickness, increase in the size of the uterus, and amenorrhœa, are usually wanting.

If after a physical examination the surgeon still feels in doubt, an anæsthetic will decide the question; as the patient becomes unconscious the abdomen diminishes in size until it becomes quite flat, as she returns to consciousness the abdominal distension reappears.

Phantom tumour occurs more especially in sterile women who have married late in life, and in women who have a morbid desire for pregnancy. It is occasionally met with in women who have borne children, and now and then in young wives. Sometimes it is seen in women who have subjected themselves to illicit intercourse and fear the results.

Smollett furnishes an admirable description of spurious pregnancy occurring in an elderly woman, in his account of the supposed pregnancy of Mrs. Trunnion (*Peregrine Pickle*, chap. x.)

A remarkable case is recorded by Havelock. The patient was seduced, and, becoming alarmed at the possibility of pregnancy, fell into a state of religious ecstasy. The rest of the family, consisting of four adolescent sons, and four daughters and the parents, fell into an ecstatic condition and remained so many days. Eventually they came to their senses, but the girl was retained in the asylum. She had many signs of pregnancy: amenorrhœa for several months, milky fluid could be expressed from the breast, and the areolæ were altered. Gradually the mental condition improved and the signs of pregnancy disappeared (*Obstet. Trans. Ed.* vol. xix. p. 183).

As to the cause of the singular mimicry no good explanation is forthcoming; conditions resembling it have been reported in the ass, and are not uncommon in petted bitches.

It is difficult to understand how this condition could be mistaken for an abdominal tumour, yet more than one case has been recorded in which the abdomen was opened to remove the supposed tumour.

In 1824, Lizars performed abdominal section in order to remove a supposed ovarian tumour, and was surprised to find only fat and distended intestines. This was in 1824, and with the accumulated experience of three-quarters of a century to guide them, this error is even now occasionally committed by surgeons.

Phantom tumour is occasionally imitated by intermitting hydronephrosis, movable kidneys, and ovarian and parovarian cysts when they burst.

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Treatment of Inoperable Tumours.—It is not often that a simple or benign tumour is beyond removal, and when it is so, it seldom endangers life, being only a source of disfigurement and inconvenience by reason of its bulk. Consequently, this article has to deal entirely with those neoplasms known as malignant, the chief varieties of which are the Carcinomata and the

Sarcomata, the former composed of a type of cell essentially epithelial, and the latter of embryonic connective tissue. Unsatisfactory as is our present knowledge of the etiology of new growths, there is very general unanimity of opinion in the profession that early and wide excision by the surgeon's knife is the proper treatment of those of a malignant nature, special attention being directed in the case of the carcinomata to the removal of affected lymphatic nodes and vessels. This tendency to involve the adjacent lymphatics is characteristic of the relations of carcinomatous growths to the surrounding tissues. The latter seem unable to offer any resistance to them, so that all the structures and organs of the body, the bones, the blood-vessels, the nerves, the air passages, the different parts of the alimentary canal, and the various viscera are affected by them. Absorption, pressure, ulceration, and metastasis are the agencies constantly at work, so that it is not surprising that tumours are frequently met with that are inoperable owing either to the existence of internal visceral or glandular deposits, or of external growths in inaccessible positions, or of great weakness and exhaustion on the part of the patient. Such cases are the most distressing that can be met with. Of recent years it is an encouraging fact that they are attracting the attention they are very properly entitled to, not only on the ground of humanity, but also because they afford an excellent field of scientific research in connection with the etiology of malignant disease.

The treatment of all inoperable tumours is best considered under two heads:—

1. The general management of all such cases.
2. The adoption of any special therapeutic measures.

General Management.—The principles underlying this are common to all these cases. They call for generous diet, fresh air and good hygienic surroundings, with digestive and other tonics. In addition, however, special measures are needed, based on the *causes* which actually bring about death.

It has been already pointed out that the leading feature of inoperable tumours (malignant) is their progressive character, so that they kill by invading adjacent tissues, the factors that are constantly at work being ulceration, pressure, and metastasis. Consequently, there are induced by these not only certain local, but also constitutional effects, and death may be the result of any of the following conditions:—

1. Hæmorrhage.
2. Exhaustion from excessive discharges.
3. Septicæmia and sapræmia.
4. Continuous pain and mental depression.
5. Stricture of vital parts.
6. Visceral deposits.

It will be as well to say a few words on each of the above points separately.

Hæmorrhage.—Bleeding in inoperable tumours is often associated with a sloughing ulceration of the tissues and with great vascularity of the new growth, so that the ordinary methods of arresting hæmorrhage cannot always be employed. It would be useless to attempt to tie a bleeding vessel in the substance of a breaking down malignant growth, or in a soft pulsating sarcoma, composed, as it is, mainly of a mass of blood-vessels. The best hæmostatic agents to rely on are pressure, cold, heat, and styptics.

Pressure, when used, must be employed thoroughly and judiciously. Small pads of dry medicated absorbent wool or strips of dry antiseptic lint, such as boric, should be carefully packed into the deeper parts of the wound or ulcer, and over these a firm compress applied. In some cases the "graduated compress" is very useful, while for the vagina and rectum "plugging" may require to be resorted to. Such plugs and pads used for the arrest of bleeding should not be disturbed too soon, yet not left too long untouched in case of septic absorption. *Cold* is a valuable hæmostatic, and may be applied in the form of cold water or ice, or by the ether spray. This latter is a very effective agent in cases of hæmorrhage. Strange as it may seem, the same may be said of *heat.* It must, however, be used at a certain temperature. Water should not have a less heat than 120° F., when it acts as a stimulant, causing contraction of muscular tissue through the vaso-motor nerves. Its value in uterine hæmorrhages has long been recognised. The actual cautery, too, is often of great service in cases of bleeding. The old cautery irons have now been replaced for most purposes by the more modern galvano-cautery, and by Pacquelin's thermo-cautery, this latter being a specially serviceable apparatus. In employing any of these to stop bleeding they should be used at a dull, almost invisible red heat, and the tissues should be made as dry as possible by previous pressure. This latter precaution applies also to the application of *styptics*—substances which often materially help in the arrest of hæmorrhage. They may act mechanically, as collodion, cotton wool, or tow, or by reason of their astringency, as hazeline. This drug is a very useful hæmostatic, and may be applied in its fluid state or by means of pads soaked in it. Other well-recognised substances are powdered alum and tannin, perchloride of iron, sulphate of copper, sulphate of iron, and nitrate of silver. Not only are these astringent, condensing the tissues and coagulating the albumin, but they are also caustic in their action, and this has to be borne in mind. Thus, the strong liq. ferri perchloridi, though invaluable as a hæmostatic, may cause considerable sloughing of the tissues if too freely applied. Probably one of the best of these iron applications is Ehrlich's "styptic cotton." It may be packed directly into the recesses of a bleeding cavity, or may be enclosed in sterilised gauze and used as a pad or plug. Possibly experience may show that the more recent adrenalin solution may prove to be our most serviceable and useful hæmostatic. In cases of bleeding from inoperable tumours there is not much scope for the internal use of any drugs, but, after taking the measures mentioned for preventing further loss of blood, recourse must be had to combat the effects of what has been already lost. Nothing is more beneficial than saline infusion. A couple of pints of sterilised salt solution introduced into the rectum, or, by means of the ordinary simple infusing apparatus, into the cellular tissue of the body, is a powerful restorative. Further, in these cases everything should be done to equalise the circulation and insure absolute rest and quietness. The food should consist of iced milk and cold soups, while all alcohol should be well diluted.

Exhaustion from Excessive Discharges.—This condition arises in connection only with ulcerated growths, and must be met by the ordinary surgical principles on which all wounds are managed. Simple cleanliness, the prevention of decomposition, suitable dressings (either dry, watery, or oily), are all points requiring attention, while the avoidance of movement and of all irritation, together with attention to drainage, must on no account be lost sight of. The prevention of decomposition is of importance, not only on account of its local effects, but as bearing on that other factor in these cases, viz. blood poisoning or septicæmia. How to obviate this will best be considered under that subject.

Septicæmia.—This is seldom seen in inoperable tumours; the form usually present arises from the absorption of the products of decomposition present in the ulcerated surface (sapræmia). Sometimes it is associated with special organs, as in the septic pyelitis of the kidney, so frequently present in advanced cancerous disease of the uterus. It is really represented by the so-called cachexia of malignant disease. It must be prevented by the use of weak solutions of the ordinary antiseptics, such as creolin, boracic acid, carbolic acid, sanitas, and peroxide of hydrogen. Where there is much superficial sloughing charcoal poultices, or dressings of wet boracic lint covered with jaconet, keep down the odour and set up a healthier action in the growth. Of the dry dressings the most suitable are ones impregnated with an antiseptic and of an absorbent character. Hartmann's wood-wool wadding, boric and salicylic wool, Martindale's moss, carbolised tow, and gamgee tissue are all excellent applications. They must be frequently changed, and are often best held in position by the triangular bandage. In the removal of dressings great gentleness should be used, and they should be well wetted if adherent, so as not to set up bleeding. In inoperable cancer of the uterus vaginal plugs soaked in a 5 per cent glycerine solution of icthyol have a cleansing and deodorising power, and they may be introduced every second day, a warm weak creolin douche being given after their removal. Sometimes curetting may be added to the use of the plugs. In some of these distressing uterine cancer cases, where the disease has eroded the bladder and a vesico-vaginal fistula exists, great comfort is derived and bed-sores prevented by the use of a specially made rubber bed-pan on which the patient constantly lies. At the Cancer Hospital it has been found of the greatest use. By keeping the bed dry it lessens the tendency to bed-sores, and it saves frequent moving of the patient. If necessary it may contain some antiseptic, such as sanitas, and thus it keeps down any odour in the discharges. Cases of inoperable cancer of the mouth and tongue are specially difficult to manage, and are often very offensive. The liquid food necessary should be given by means of a drinking cup with a piece of tubing attached and placed far back in the fauces. Any loose teeth should be extracted, and the mouth should be syringed out and washed out constantly with Listerine or lotions containing eucalyptus. This latter seems the most efficient deodoriser in these cases. If the case is very offensive a formaline lamp may be burnt in the room, care being taken not to render the air too irritating. Where the flow of saliva is very great belladonna as atropia may be administered. Space does not allow of individual cases being further dealt with, but to all of them the principles of cleanliness, prevention of decomposition, and avoidance of irritation must be applied, and when emaciation sets in the prevention of bed-sores by the use of water-beds and all the recognised local measures must be kept in view.

Pain.—This, together with a certain amount of mental depression, is more or less present in all cases of inoperable growths, but the pain is not always of that agonising character that popular fancy associates with cancer, and its injudicious management is, I am sure, responsible for much additional distress in many of these cases. The too early and indiscriminate use of narcotics is not to be followed. Pain and suffering must be relieved, but this may be done by analgesics without recourse to morphia, a drug which not only upsets the digestive organs, leading to emaciation and anæmia, but has the very great drawback of destroying the patient's self-control, so that when once begun it has to be constantly renewed to meet the restless, clamouring craving for it that is set up. These remarks do not apply to the systematic administration of opium in inoperable cancer, as advocated therapeutically by Dr. Snow, not with the object of killing pain, but of checking the growth of the cancer cells. They refer more to the hypodermic injections of morphia resorted to in a routine manner. Of the analgesics that may be employed my preference is for phenacetine, administered in 10-20 gr. doses, to relieve peripheral neuritis and restlessness, either occasionally or regularly during the day and night. It has a remarkable effect in soothing the general uneasiness and mental depression present in these cases. During the daytime it usually suffices, but sometimes it has to be replaced at night by trional, bromidia, nepenthe, or morphia hypodermically, so as to ensure a quiet night. This, however, is the exception, and it occurs more towards the close of a case. From considerable experience at the Glasgow Cancer Hospital I am satisfied that observance of the above suggestions is of importance to the patient, and renders easier the general management of the case. In some cases neurotomy may be of service, as of the lingual nerve in cancer of tongue.

Stricture of Vital Parts.—It is in connection with growths of the œsophagus, pylorus, and rectum that this factor comes into play. Every case must be judged on its own merits, but there are few cases of œsophageal disease where gastrostomy is called for. In the majority of them the narrowing may be met by the judicious use of bougies or Symond's tubes, combined with a liquid diet. In pyloric obstruction gastro-enterostomy may advantageously be resorted to, while in cases of rectal disease a left iliac colostomy prolongs life, relieves distressing symptoms, and materially adds to the patient's comfort. In these latter cases a special apparatus may conveniently be worn.

Visceral Deposits.—All that can be done for these is to mitigate the distressing symptoms they give rise to. Digestive and pulmonary irritation must be met by the ordinary remedies, while the distress caused by pleural effusion and by ascites must be relieved by frequent tapping or the use of Southey's trocars. In the persistent vomiting which often accompanies cancer of the alimentary canal, not arising from obstruction so much as more commonly from a subacute form of peritonitis accompanying the disease, pills of oxalate of cerium and cocaine, and of cocaine and morphia have been specially praised. Abdominal counter-irritation by turpentine stupes and by linseed and mustard also does good.

The Adoption of any special Therapeutic Measures.—In addition to the general management of these cases we have always to keep an open mind on the possibility of any special therapeutic measures doing good in any particular case, for experience has emphasised two points in connection with inoperable tumours, viz.: (1) the *capriciousness* of malignant disease, and (2) the reality of the *retrogression* of cancer. All medical men are familiar with the fact that the characteristics and the rate of progress of malignant disease vary with each individual, while there seems, apart from errors in diagnosis, reliable evidence that in a certain number of cases of cancer spontaneous retrogression of the disease has taken place. Both these factors have to be taken into account in testing the value of any new methods of treatment, and at the same time it is clear that, while viewing with distrust all the so-called "cures" for cancer, our management of these cases should be carried on in a spirit of hope rather than of despair, and that attention should be directed towards any suggested therapeutic measures. As several of these have attained a certain measure of success, in that there has been under them some amelioration of symptoms and prolongation of life, they are entitled to some consideration.

As pointed out in the remarks on the general management of these cases, the use of the knife for neurotomy, gastrostomy, gastro-enterostomy, and colostomy may improve the patient's condition and in many ways benefit him, so its employment for the ligature of the vessels supplying a tumour has been advocated and practised with some benefit in a certain number of cases. Entirely palliative as these measures are, others have been suggested having a more curative aim. They may be classified as follows—

1. Diet.
2. Drugs—(*a*) Internally, (*b*) Injection.
3. Bacterio-Therapy.
4. Serum-Therapy.
5. Organo-Therapy.
6. Photo-Therapy.
7. Electricity.

Diet.—Complete abstinence from red meats and from stimulants has been advocated, but results have not endorsed the idea, and though milk and white meats seem to suit some, the majority of these cases do best with a generous diet.

Drugs.—Internally: celandine (Spivach), chian turpentine (Clay), arsenic (Campbell de Morgan), opium (Snow), cacadylate of soda (Paque), have all been tried internally, but have not established their reliability. The same may be said of the parenchymatous injection of various irritating substances such as acetic acid, alcohol, methyl-violet, venom of cobra di capello, formalin and soap, or of agents calculated to produce suppuration artificially, such as oil of turpentine, arsenious acid, and calcium carbide.

Bacterio-Therapy.—Under this head come inoculations of the streptococcus of erysipelas, and of this micro-organism modified by admixture with the bacillus prodigiosus and known as "Coley's fluid." The use of the former has been largely replaced by that of the latter, which is practically useless in cases of cancer, but has undoubtedly been of value in a certain number of *spindle-celled sarcoma.* It must be used cautiously. A beginning is made by injecting subcutaneously in the vicinity of the tumour ½ minim of the fluid, the reaction caused being watched, and the amount increased to 2 minims. If there is no response to treatment in three to four weeks there is no good continuing.

Serum-Therapy.—Anticancerous serums, such as those of Vlaieff and Roquette, and the thymus serum of Foulerton, have been tried, but without any definite results. Foulerton admits that so far nothing more than mere transient effects have followed the injection of his serum.

Organo-Therapy.—This includes the administration of thymus extract, lymph gland extract, thyroid extract, and oöphorectomy. Thymus extract, as administered by Foulerton, has not had an extended trial, but so far it would seem, like the serum, not to produce any distinct effects. The same may be said of Snow's lymph gland extract. Thyroid extract, on the other hand, has been a good deal used, and opinions differ as to its utility. In the medical journals some practitioners speak well of it, while others have no faith in it. Theoretically it should be of service, because of its known effect on the lymphatic system, the one that is paramount in importance in carcinoma. My own experience is in favour of it, but its effects should be watched, and only those cases chosen that it agrees with. The body weight is a good guide on this point. It should be begun in small doses of 3 grains daily, and increased up to 15 grains.

Oöphorectomy was originally put forward seven years ago as a beneficial measure in inoperable mammary cancer, and the experience gained since then has been confirmatory of that view. It has not been universally successful by any means, and time has shown that many of its effects are transient, but judged by the principles underlying all operative work in cancer, viz. the prolongation of the patient's life and the alleviation of the local trouble, it has not been found wanting, for cases of inoperable mammary cancer are forthcoming in which the beneficial effects of relief from pain and discomfort, of wasting and disappearance of masses of cancer and enlarged glands, and of marked improvement in the general health, as shown by gain in weight and improvement in strength and spirits, have continued for some years. Applicable only to inoperative mammary cancer with its local and glandular recurrences, it would seem that oöphorectomy cannot be relied on in every case, and that it should not be resorted to in cases where there are evident visceral deposits. When performed, experience is in favour of combining it with the administration of thyroid extract.

Photo-Therapy.[1]—As curative agents the Finsen's light and the X-rays have been of late resorted to in cases of sarcoma and carcinoma. There is sufficient evidence already forthcoming to show that in both of them we have a successful method of treatment for rodent ulcer and for surface carcinomatous disease. Under them healing takes place, pain lessens, and discharge diminishes. Their action seems selective of cancerous tissue, and to be irritating to and destructive of it. We are not yet in a position to say whether these apparent curative effects are permanent. From what I have seen I am satisfied that the X-rays, especially in these cases, may be dangerous, and that they require careful watching. Space will not allow of the details of application being given here, but each "sitting" lasts usually about 10 to 15 minutes, and is given on alternate days. No cases of sarcoma being benefited by photo-therapy have yet been published.

Electricity.—This has been used in different forms from time to time. We have had the "electric puncture" of Reading of Philadelphia, and the "kataphoresis" of Massey, where the positive pole is coated with mercury, forming an oxychloride of mercury, an infinitesimal part of which acts lethally on the cancer cells and leaves the normal cells undisturbed. More recently we have had high frequency currents introduced, and in the hands of some of the operators very striking results are said to have been obtained. I have not had any personal experience in their use, and I know of no published cases that prove satisfactorily the value of electricity thus employed in inoperable tumours.

In conclusion, I would say that as matters stand at present we have no remedial measures in inoperable tumours that can be spoken of as *curative.* Many of them are decidedly *palliative,* and as such are entitled to proper recognition. Coley's fluid, oöphorectomy, thyroid extract, Finsen light, X-rays, have all their appropriate sphere of action, in suitable cases prolonging life and ameliorating the patient's condition. A great deal has, however, yet to be learnt about them, and it behoves everyone working at this subject to do so in a scientific spirit, making absolutely sure of the exact nature of the cases dealt with, so that the results obtained may have a real value. Above all, let not valuable time be spent in operable cases in having resort to any of the above measures in preference to that early, free, and wide removal by the surgeon's knife that all experience points to as being the only safe and reliable method of treatment in cases of malignant disease.

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[1] This subject is further discussed under X-rays, vol. xiii.

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See also "Warts"

Growths in this situation may be dealt with broadly under the headings of malignant and benign. Taking the former class first, they may be divided up as follows:—

Carcinoma.—Apart from the lips and anus, cancer of which parts has been dealt with elsewhere ("Mouth," vol. viii.; "Rectum," vol. x.), it is very rare for true epithelioma to develop without some precedent morbid condition, usually of long standing, or as a complication of congenital benign formations, such as nævi, moles, and so forth.

Crateriform Ulcer.—Under this name Hutchinson has described a clinical variety of epithelioma cutis (1), which he has seen arise in a primary manner; but it has also been observed as developing on a previously existing rodent ulcer (2). Like the latter it affects much the same regions of the upper part of the face, but, unlike rodent ulcer, it runs a rapid course. It may commence as a bossy rounded lump, which quickly increases in size and breaks down at the summit, giving rise to a crateriform appearance. Histologically it is an epithelioma. Radcliffe-Crocker records a case in which it developed about the inner canthus, and was at first thought to be a rodent. The microscope showed it to be epitheliomatous. A somewhat similar kind of growth was figured by Rayer among his drawings of cancer (3).

In old people the dirty, wart-like growths (senile warts, or senile, flat, seborrhœic warts, *fleurs de cimetière*) which occur about the face and body may in some instances become epitheliomatous.

Epithelioma sometimes develops in *lupus vulgaris* (4). This complication is infinitely more rare in *lupus erythematosus* (5).

Chronic infiltrated patches of dermatitis are in very rare instances liable to become cancerous, especially if scratched and worried, and may lead to death, by involving the corresponding lymphatic glands, and becoming generalised in the viscera secondarily.

The same malignant development may take place in old scars and ulcers (6).

Other instances of epithelioma arising as a result of precedent skin affection are cancer following *eczema ani*, and in another case developing from a *cornu cutaneum.*

Paget's disease has been described elsewhere (*Encycl. Med.* vol. vii. p. 338), but it may be incidentally mentioned here that the condition has been observed on the penis (7), the scrotum (8), and vulva (9).

Chimney-sweep's cancer need merely be alluded to in passing. Workers in tar and paraffin may be similarly affected (10).

Cancer en cuirasse must also be referred to (vol. xi. p. 19).

Seaman's skin cancer is the name given by Unna to cancerous complications occurring after erythemata and hyperkeratosis of long standing, and as a result of exposure to weather (11).

Cancer has also been described as developing in old *syphilitic ulcers* and *scars*, on *psoriasis* patches, in the *scars* of old *burns*, and so forth.

Melanotic cancer has of late years been shown to be the true state of affairs in cases formerly included under the melanotic sarcomata. Cruveilhier, however, many years ago *clinically* designated melanotic growths under the former heading (12). These cancers arise in pigmented moles.

Cancer about the *nails* is of very rare occurrence. I have referred to a case of this kind, recorded by J. Hutchinson, jr., in my article on "Affections of the Nails" (*Encyclop. Med.* vol. viii.)

The prolonged use of *arsenic*, by leading to epithelial changes, may give rise to cancer of the skin. An unusual case of *arsenical keratosis* becoming cancerous after arsenic had long ceased to be taken has been noted by Radcliffe-Crocker and Pernet (13).

Korowin had a case of primary cancer of the hairy scalp, which generalised, leading to more than 200 metastatic embolic nodules in the skin of the face, trunk, and limbs. The lungs were also involved (14). An anomalous case of multiple carcinomata has been recorded by Allworthy and Pernet, in which growths developed about the right buttock and adjacent parts. The patient died three and a half years from the onset, but no necropsy was allowed (15).

The large growths which sometimes develop in *Xeroderma pigmentosum* may also be epitheliomatous. A recent instance of this has been described by Pernet (16).

Secondarily, subcutaneous multiple carcinomata occur in the last stages of cancer of the stomach, liver, and so forth. Their surface generalisation is a sign that the end is not far off.

The treatment for cancer of the skin is removal, widely and deeply, whenever excision is possible. This is specially important in the case of the melanotic growths. The sooner a growing pigmented mole is removed the better, for generalisation and a fatal issue are rapid in neglected cases. When there are numerous subcutaneous growths, secondary to internal cancer, removal is, of course, out of the question.

Where excision cannot be carried out for various reasons, the X-rays might be tried, but not much is to be expected from their application. When caustics, such as Vienna and other pastes, are used they should be applied very thoroughly. The growth sloughs away, and it has been recommended to graft when the wound is granulating healthily. Arsenic internally is no use. Morphia and opium should not be withheld where there is pain. In hopeless cases, euthanasia must be aimed at.

Endothelioma cutis may be mentioned in this place. Under this name a rare condition has been described, in which the scalp becomes affected with multiple growths, giving rise to a characteristic appearance. They grow very slowly, and do not lead to metastases, the general health remaining good. These scalp tumours have been found in two and more generations. Histologically they have been described as developing from the endothelia of capillaries. The face and upper part of chest may be affected, as in Ancell's case, which apparently was an example of the disease (17).

Sarcoma.—Under this heading German writers have formed a complex group. Space will not allow in this place of much refinement in the direction of division of the subject. The bibliographical references given at the end will be found useful by those wishing to go more deeply into the matter (18). Here the following will be dealt with :—

Melanotic Sarcoma.—This well-known condition may arise in pigmented moles. It is intensely malignant, and may lead to the formation of numerous growths in the skin, varying in size from peas to filberts, and also attack the viscera, with a rapidly fatal result.

It is of the greatest importance, therefore, to remove at once any mole that is growing, becoming more deeply pigmented or ulcerating, for if not dealt with early a fatal result will certainly ensue. Tinkering treatment is especially to be reprobated in such cases.

Under the name of *melanotic whitlow*, Hutchinson has described a form which begins as a chronic onychitis, with very little pigmentation, followed by the formation of a fungating tumour. Generalisation rapidly takes place.

Idiopathic multiple pigmented Sarcoma.—This condition, extremely rare as far as this country is concerned, but more frequent in Austria, Russia, and Italy, was first described by Kaposi. Since the fact has been made out that the coloration is due to blood, the designation of Köbner, sarcoma idiopathicum multiplex hæmorrhagicum, is more to the point, and has been accepted by Kaposi.

The disease apparently affects Jews in a special manner. One of the cases observed in England (19) was a Jew from Poland. But it affects non-Jewish individuals also.

It first attacks the soles and palms, hands and feet, and gradually and successively the fore-arms and legs, arms and thighs. It may spread to the face and trunk.

The tumours are brownish-red to bluish-red, vary in size from a shot to a hazel nut. Their surface is smooth and their consistence firm and elastic. They remain either discrete or coalesce. They may undergo some involution, or break down from gangrene. Towards the last other parts become involved, mucous membranes of mouth, and so forth, as may also the liver, etc. the disease going on altogether for two, three, or more years before death closes the scene. Recovery may in rare instances take place. Males are more frequently attacked than females, and the younger the patient the more rapidly fatal is the disease (19).

Histologically they are very vascular, spindle-celled sarcomata, with hæmorrhages and deposition of pigment, occurring in them.

As to treatment, the only thing that has proved of any avail is arsenic in subcutaneous injections. This was first introduced by Köbner. He used a solution of liq. arsenicalis in the strength of one part to two of aq. dest., and injected two and a half to four drops once a day, raising the dose to seven and a half and nine drops (20). This treatment requires to be carried out steadily for months. Cacodylic compounds might be tried in the same way, but with care.

In the case of *non-pigmented sarcoma cutis*, the growths may be very numerous, but they are mostly subcutaneous in situation, and the result of generalisation from internal sarcoma. A sarcomatous development has occurred as a complication of *Recklinghausen's disease* (*i.e.* the association of multiple fibromata, neuro-fibromata, and pigmentation of the skin) (20).

Congenital multiple sarcomata cutis is extremely rare. An interesting case of the kind was observed in Dr. Radcliffe-Crocker's clinic, University College Hospital. It occurred in the practice of Dr. Jordan Harvey. Some of the growths were examined by Pernet (21). There were seventy growths about the face, back, and flexor aspect of limbs. Histologically, they were of the small, round cell variety, very vascular (angeio-sarcomata), and situated in the corium. Unfortunately no necropsy was permitted, so it could not be decided whether the growths were primary or secondary. One or two other cases have been recorded (22), but Ramdohr's was most like the one just referred to, and in that case the kidneys and lungs contained growths also (22).

C. Boeck of Christiania has given the name of *multiple benign sarcoid of the skin* to a condition which may be considered in this place, benign though it be. It consists of a widespread, symmetrical eruption about the head and extensor surfaces of trunk and extremities. It is made up of firm nodules, varying in size from a hemp-seed to a bean. They involve the whole skin, and are movable with it. In addition, the lymphatic glands are much swollen, and there is a slight increase in the number of white corpuscles. Histologically it has affinities with sarcoma, and also with rare cases of so-called pseudo-leukæmia. This benign sarcoid clears up under arsenic or spontaneously (23).

In *leukæmia*, the skin may become affected by growths varying from a pin-head to a hazel nut in size, discrete or confluent, pale to brownish-red in colour, and distributed about the face, trunk, and extremities. The growths are made up of lymphoid cells. Growths have also been described in *pseudo-leukæmia*, but Nékàm and Pinkus differ in their conclusions (24).

Tumours of the skin occur in *mycosis fungoides* in the various forms of that complaint, either in the later stages, or they may be the first manifestation (*forme à tumeurs d'emblée* of French writers); or again in the course of the so-called *lymphodermia perniciosa* (of Kaposi), now included under mycosis fungoides. The growths may attain the size of a mandarin orange, and do not recur after removal. German writers include this disease *à la suite* of sarcomatosis cutis. But as it has been shown that it is microscopically of granulomatous structure (and named for that reason *granuloma fungoides* by J. F. Payne), it should be kept separate from the sarcoma group (25).

Chloroma is the name given to light green tumours of very rare occurrence, which chiefly affect the periosteum of the skull-bones, and consist of round cells with reticulated framework. Ziegler places them under the lympho-sarcomata. These tumours may involve the skin (26).

RHINOSCLEROMA.—This is a very rare disease in this country, but it is not uncommon in Austria, where it was first described by Hebra and Kaposi. Other cases have been recorded in Russia, Italy, Brazil, and other countries.

It is a growth of stony hardness to the touch, which affects the nares and adjacent parts, both true skin in one direction, such as that of the upper lip, and mucous membranes in the other, in the latter case slowly invading the naso-pharynx, and even involving the trachea and larynx. Nodules and flat infiltrations are observed. It is microscopically made up of granulation tissue cells, with vacuolization and hyaline degeneration in parts. The latter altered cells contain the specific bacillus.

Although the disease is not malignant in the ordinary sense of that word, as it does not affect the general health and is localised, yet its slow but sure extension, and its rebelliousness to treatment, exclude it from the benign group of tumours. There is no tendency to spontaneous involution, and the disease goes on for years. It is, of course, a bad look-out when it involves the larynx and pharynx, for dangerous symptoms of obstruction would have to be dealt with.

Excision is no use, as the growth recurs. Mechanical means must be employed to prevent the blocking up of the nares. Lang used metallic tubes covered with salicylic plaster to introduce into the nostrils; at the same time he injected a 1 per cent solution of salicylic acid into the growth, and exhibited the drug internally. When blocking has taken place, sharp spooning or boring through with caustic potash would be the line to take. A masterly inactivity is indicated when there is no discomfort.

The most likely things it could be mistaken for would be epithelioma and syphilis. As to the former, the fact that rhinoscleroma does not break down and ulcerate, and the very slow growth, together with the situation and so forth, would help to differentiate it from cancer. With regard to syphilis, specific remedies have no effect on rhinoscleroma. The microscopical examination of a portion of the growth would reveal its true nature. The bacillus stains well with methyl-violet (27).

Before going on to *benign tumours of the skin*, a brief reference to *cysticercus cellulosæ cutis* may be made here, chiefly on account of the possibility of these subcutaneous growths being taken for malignant manifestations. But they have also been taken for fibromata, gummata, and so forth. They occur as firm, elastic tumours, from about a pea to a hazel nut in size, disseminated about the trunk and limbs. Wolff says as many as 2000 have been counted. The skin over them is unaltered either in colour or otherwise. The complaint is very rare in this country, but is less so where raw or improperly cooked pork is indulged in, as in Germany. Patients may also have cysts embedded in the mucous membranes of lips and tongue. When the tumours are well filled with fluid, they may give the impression of solid growths. Excision or puncture would reveal the characteristic hooklets of the parasite. When the skin alone is affected, the disease does not give reason for anxiety. But the prognosis becomes grave when fits occur, as this shows involvement of the brain by the parasite. Cystic growths may also occur about the heart coverings. The tumours may calcify and shrink in time (28).

Benign Tumours

Molluscum Contagiosum.—In this disease, growths varying in size from a large pin-head or so, in the earliest stage, to a pea or larger, occur about the skin, chiefly the face, breasts, and nape, but they may also develop on the abdomen and external genitalia. They are firm, sessile, prominent, solid tumours, hemispherical in shape, with slightly flattened top, pearly white or pinkish in colour, and usually umbilicated. These are the points that make the diagnosis.

The morbid process takes place in the Malpighian layer of the epidermis. Microscopical sections show wedge-shaped lobules, the result of special changes in the cells, which enlarge and undergo degeneration, the so-called molluscum bodies, accompanied by an obliteration of the papillary processes. The accumulation of these cells leads to breaking down of the horny stratum at the centre of the tumour. By some observers these molluscum bodies are looked upon as coccidial parasites. The contents can then be squeezed out, leaving a hole behind. Or the growth may undergo a process of ulceration, leading in some instances to an angry-looking sore, which, when situated about the mouth or face, may give rise to a suspicion of primary chancre. But the glands are not enlarged, and the characteristic molluscum lesions would be found in the neighbourhood, if carefully looked for.

Very large growths have been recorded. Colcott Fox recently showed an extremely extensive case—a woman, in whom there were a number of growths on the scalp and adjacent parts of the face, the condition having been overlooked and allowed to progress unchecked before the patient came under his observation. Clinically, it might to unpractised observers have suggested malignant growths (29).

As the name indicates the disease is contagious. It may be seen to occur in mother and suckling, about the breasts of the former and the face of the infant.

The condition is also found about the nape of those who indulge in what the late Sir Richard Burton (30) referred to as the "absurdly called" Turkish bath, and who neglect to spread their towel over the blocks used as head-rests.

Salzer (31) has recorded an interesting case of the eyelids in a lady in the habit of feeding pigeons. The development of the growths in her case coincided with an epidemic disease among the birds, the chief symptoms of which were growths about the beak and emaciation. The growths on the beaks were like those in Bollinger's plate (32) of *epithelioma contagiosum* in fowls. (This name, by the way, is the German equivalent for our *molluscum contagiosum.*) Shattock has exhibited growths of the same kind in buntings (33); and I have myself had a canary which developed a small tumour of the beak, became emaciated, and died, the growth no doubt belonging to this category.

The treatment is to lay each little tumour open with a knife, the back of which is directed towards the skin, and thoroughly squeeze out the contents between the thumb nails or the handle of the scalpel and thumb nail, as Radcliffe-Crocker recommends. Even the smallest should be dealt with, for they will grow and become a source of fresh ones. They may be touched with a wooden match-end dipped in acid nitrate of mercury, but a small incision as aforementioned is the better way.

ADENOMA SEBACEUM.—This condition had been described under various names (34) before it received the one of adenoma sebaceum. It consists of small growths, from a millet seed to a split pea in size, distributed about the sides of the nose and naso-labial folds, in which situations the lesions are usually very closely aggregated, whereas on the chin, cheeks, and forehead they are more discretely scattered. They are more or less convex, varying from an almost colourless hue to a bright red, the latter being due to small dilated vessels.

The disease is congenital, and the lesions gradually increase in size and number. In the majority of cases the patients are mentally dull or epileptics (35). They are to be found in asylums for idiots. But in some instances there is no sign of intellectual inferiority.

In many, small fibromata are scattered about the skin. Radcliffe-Crocker has pointed out that associated with the disease there is frequently a flat fibrous-looking infiltrated patch about one or other iliac crest.

A careful examination would differentiate it from acne rosacea, which it resembles in distribution, but not in the history, mode of development, and character of the individual lesions.

It is essentially a sebaceous growth, but the microscopical features have varied somewhat in individual cases (36).

Owing to the toughness of the growths, sharp spooning has to be done vigorously, and even then recurrence may take place. Where the lesions are few in number Radcliffe-Crocker found electrolysis effectual; in another case, where the lesions were semi-confluent about the naso-labial folds, he excised portions, bringing the edges together to heal by first intention.

EPITHELIOMA ADENOIDES CYSTICUM is the name given by Brooke of Manchester (36*a*) to a condition of the skin of the face chiefly characterised by small pearly or pinkish growths, usually rounded and smooth, from a pin-head to a small pea in size, distributed about the eyelids, the root of the nose, forehead, naso-labial folds, and chin, but they may also occur on the upper part of the trunk. It begins usually about adolescence, affecting both sexes, but giving no trouble except for the disfigurement.

Microscopically it is an epithelial growth, but it is benign (hence name of *multiple benign cystic epithelioma*, which has also been given to it). But the possibility of true epitheliomatous development must be borne in mind; this occurred in a case of White's of Boston (37). Authors have described variations in the microscopical features, hence a whole string of names which need not be enumerated here.

Curetting or excision are the best ways of dealing with these small growths. But electrolysis and cauterization have also been recommended.

FIBROMA, NEURO-FIBROMA, and NEUROMA (see general article on "TUMOURS," p. 455).

KELOID has been dealt with in vol. ii. of the *Encyclopædia Medica*, p. 290. But a few remarks may be allowed here. In the first place, true keloid must be distinguished from hypertrophic scarring. In the latter case, when the hypertrophy remains limited to the original scar, without a tendency to spread into the surrounding tissues in the characteristic claw-like manner, it cannot strictly be included in the category of true keloid, but the dividing line is sometimes a fine one.

Keloidal or hypertrophic scarring has been described as occurring after vaccination. In a case of Ehlers, of Copenhagen, this complication attacked five vaccinated areas in a child of six and a half. The interest of this case lies in the fact that the lesions were subjected to the Finsen light treatment, but without any good effect (38). Radcliffe-Crocker has employed the X-rays in a similar case (39). It would be interesting to know if negroes, who are racially very prone to true keloid, frequently react in this way to vaccination.

Another mode of treatment for hypertrophic scars is the local injection of an 8 per cent solution of thiosinamin.[1] Twenty minims are injected at a time with a hypodermic syringe at various points along the border of the lesions, once or twice a week. In this way good results have been obtained in Dr. Radcliffe-Crocker's clinic (40). Multiple scarification—mincing up the scar really—has been recommended, but it is painful, as are also local creasote injections. Electrolysis is also useful—at any rate it acts beneficially where the irritation and pricking is a marked feature (40).

Keloid complications (? really hypertrophic scarring in some cases) have been observed as a result of syphilides. I have myself seen it follow ulcerative secondary lesions. An extensive case of the kind has been recorded by Arthur Shillitoe (41). These growths may or may not disappear under specific treatment.

Hypertrophic scarring is well known in bad cases of *acne vulgaris*. And in this place the *acne keloid* of the occiput, in which tufts of hairs project through the thickened scar, may be alluded to. It is the result of long-standing suppurative folliculitis of this part, to which Kaposi has given the unwieldy name of *dermatitis papillaris capillitii*. The process may be associated with severe acne vulgaris and sycosis barbæ.

Hypertrophic scarring may also be a sequela of other eruptions.

NÆVI have been dealt with under "ELECTROLYSIS" (*Encyclopædia Medica*, vol. iii. p. 256); and MOLES have been considered under "TUMOURS" (p. 461). A point to bear in mind is that nævi may give rise to cancers, and moles to melanotic malignant growths.

As to the treatment of nævi, it is sometimes possible, where the situation and size are favourable, to obtain a cure by vaccinating upon them with due care.

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[1] I am indebted to Mr. Harold Wilson, Teacher of Pharmacy, University College Hospital, London, for pointing out that 8 is a better solution than 10 per cent, as in the latter the thiosinamin is thrown down in part and necessitates heating of the solution before using, whereas an 8 per cent solution remains clear. The formula is : Thiosinamin, 8 parts ; glycerine, 20 parts ; sterilised (distilled) water, 72 parts.

In dermatological literature numerous cases of extensive nævi and moles have been recorded, but they need not detain us here.

LYMPHANGIECTODES (42), also known in this country as LYMPHANGIOMA CIRCUMSCRIPTUM (Malcolm Morris), is an affection which was first described by English writers. It is a localised disease consisting of closely aggregated deep-seated vesicles looking like frog-spawn, occurring in patches about various parts of the body—face, lip, neck, trunk, and limbs, but limited to one region. Apart from the grouped vesicles, these may also occur scattered about in twos and threes. They vary in size from a large pin-head to a hemp seed or so ; and may be either colourless, pinkish, or red, or even of a blackberry hue (hæmorrhagic). They may occur as closely aggregated lesions, situated on an infiltrated patch, of a fibro-fatty consistency to the feel. Vesicles of a similar nature have also been observed on the conjunctivæ and tongue, and when pricked lymph-like fluid flows.

The disease begins in infancy or early life, and is chronic. Microscopically, the striking features in the sections are the dilated, cystic looking, lymphatic spaces in the corium (43).

The designation of lupus lymphaticus employed for this condition by Hutchinson is misleading, for the disease has nothing whatever to do with lupus.

The treatment is to excise the patch or destroy it with caustics. In either case a recurrence may take place in the neighbourhood of the resulting scar. Radcliffe-Crocker has had some success with electrolysis. But it may be wise to leave it alone altogether, unless thorough excision can be carried out. In the latter case this might be followed up by grafting with the whole depth of skin from elsewhere, according to the method of Wolff; or even Thiersch grafting might be tried. It would depend on situation and other circumstances.

LYMPHANGIOMA TUBEROSUM MULTIPLEX was the name first used by Kaposi (44) for another unusual condition, and although subsequent research has shown the condition to arise from the blood-vessels of the skin, and not to be of lymphatic origin, it is as well, perhaps, to stick to the original accepted designation rather than adopt such a name as hæmangio-endothelioma tuberosum multiplex.

The disease is a very rare one, and consists of nodules about the size of lentils or larger ; round, or, in the case of the larger ones, oval ; of a yellowish to brownish red hue and smooth surface. They are moderately elevated above the level of the skin. In distribution they may affect the front of the body, upper part of chest, the back of the neck. The disease usually begins in childhood or youth, but it may begin later in life. The nodules increase slowly in numbers and more slowly still in size (45).

Microscopically, the striking feature is the number of cyst-like formations containing a colloid mass. Descriptions vary according to authors, but the growth appears to be really an endotheliomatous one springing from the vessels. It must be distinguished (46) from epithelioma, adenoides cysticum, or as Unna has named it, *Acanthoma adenoides cysticum* (see 45).

MYOMA MULTIPLEX CUTIS.—This is another very uncommon disease. It has been especially studied by Besnier. These small tumours of the skin vary roughly from a pin-head to a bean in size, and firm to the touch. They are some shade of red or yellowish red in colour, but they may be pale like the skin. The growths are usually grouped. They have been observed on the trunk, limbs, back, over the lower jaw, etc. ; and are embedded more or less in the skin, and are movable with the latter. Paroxysmal spontaneous pains may occur in them ; they may also be painful on pressure. They appear at various ages in adults. Malcolm Morris has shown instances of these growths occurring in father and daughter (47).

Histologically the growths are made up of smooth muscle fibres, and no doubt originate from the arrectores pilorum (48). The van Gieson method of staining is a good one for sections. Excision is the only effectual treatment.

URTICARIA PIGMENTOSA is sometimes nodular, as in the case depicted by Radcliffe-Crocker (49). (*Urticaria pigmentosa* will be dealt with under Urticaria.)

XANTHOMA PALPEBRARUM is the name given to yellow plates of new growth which affect the eyelids. It usually begins about the internal canthus of the left upper eyelid, but it may start elsewhere—for instance, near the external canthus of the right lower eyelid. It then spreads, and later involves the other eyelids, in some cases forming more or less of a semicircle round the eyes.

There can be no difficulty about the diagnosis. The plates are embedded in the skin, and are of the colour of chamois leather. The disease shows a family prevalence and may be hereditary.

XANTHOMA MULTIPLEX is more rarely seen. It affects, in addition to the eyelids, the flexures and mucous membranes, and in severe cases may be widely distributed, involving also the elbows and knees, palms and soles, and so forth. It is often associated in adults with chronic jaundice, malignant disease of the biliary apparatus, and so forth, but in youths there may be no derangement whatever of the general health, and nothing more than the yellow growths about the knees and elbows, which give no trouble. In the latter case it may occur in more than one member of a family (50). When the lesions, instead of being flat plates, are rounded, prominent, nodular, the disease goes by the name of xanthoma tuberosum, to distinguish it, clinically merely, from xanthoma planum (51).

There are differences of opinion as to the pathology. Microscopically the growth consists essentially of masses of "xanthoma" cells in the corium (52). The yellow and brown granules are partly in the ordinary connective tissue cells, partly in the epitheloid cells, partly free.

Xanthoma elasticum (Balzer), or *pseudo-xanthoma elasticum* (Darier). This is a rare condition, in which Balzer found that elastin formed the greater part of the tumour, but more recently Darier concluded it was not xanthoma, as he did not find "xanthoma" cells (53).

The treatment of xanthoma consists in excising the growths. Great care must be exercised in dealing with the eyelids so as not to produce a condition of ectropion or epiphora. But most patients will prefer to be left alone.

COLLOID-MILIUM of the skin was first described by Wagner. The growths, which vary from a pin head to a split pea in size, are glistening, of a pale yellow tint, and embedded in the skin, especially about the cheeks, orbits, and forehead. A jelly-like mass can be got out of them when opened. It is extremely rare (54).

BOTRYOMYCOSIS.—Under this name softish tumours which occur singly about the hands have been described. The growths are pedicled, about the size of a Barcelona or hazel nut, and are some hue of red with exuding granulations on the surface. They are painless.

A case of this kind came under my observation when I was assistant to Sir Victor Horsley at University College Hospital in 1892. The patient was a woman of about fifty, with a pedicled growth the size of a Barcelona nut on the dorsum of the terminal phalanx of the left little finger, just behind the nail. It had begun as a pimple which had been cauterised several times; its surface was blackish when I saw it. At that time I did not know what it was, but I removed it in the out-patient's department under an anæsthetic, taking a circle of healthy skin round the base of the pedicle with it. It was dressed with sal alembroth gauze, and it did well (55).

Since Poncet and Dor first described it in 1897, there has been some discussion as to its cause, but everything points to its being of staphylococcal origin, and in this the veterinary surgeons agree (56).

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Tylosis. *See* Ichthyosis (vol. v.).

Typhilitis. *See* Appendix (vol i.).

Typhoid Fever.

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Synonyms: *Abdominal Typhus; Enteric Fever; Gastric Fever; Seven Day Fever, etc.*

Definition.—A continuèd fever caused by the entry of a specific micro-organism—the bacillus typhosus—or of poisons arising from it—into the blood; anatomically characterised by hyperplasia, and usually ulceration of Peyer's glands, enlargement of spleen and of mesenteric glands; clinically manifested by some or all of the following symptoms:—Pyrexia, roseolous eruption, enlargement of spleen, evidences of general toxæmia, and symptoms due to local lesions situate for the most part in the intestinal and mesenteric glands.

Geographical Distribution.—It is endemic in Great Britain, but is lessening in frequency under the influence of improved hygienic conditions. It is met with throughout Europe, Asia, Africa, and America.

Etiology.—Discussion as to the proximate cause of typhoid fever has become superfluous since the discovery by Eberth in 1880 of the specific bacillus typhosus. This organism has been found in the spleen, the mesenteric glands, the lymphoid tissue of the intestines, the medulla of bones, the kidneys, the liver, the roseolous eruption, and in the blood of the dead and of living subjects of typhoid fever; it has also been detected in the placental blood, and in the organs of the new-born fœtus of a mother affected with the disease.

It abounds in the typhoid stools during the first fortnight of the malady, sometimes persisting throughout convalescence; it is to be found in a considerable percentage of cases in the urine after the first few days, frequently in the bile, and probably also in the sweat and the sputa. It is found in the pus from some, but not all, abscesses occurring in the course of the fever, and it may persist in such abscesses for even years after the disease.

Characters of the Bacillus.—The bacillus is 2-3 μ in length and 1-8 μ in thickness, longer and thicker than the typical bacillus coli, to which it bears a close resemblance; when stained shows ten to twenty-four wavy flagellæ, longer than the bacillus itself; the termination may show a glistening rounded body, really retracted protoplasm—in cultivations it is single; often in chains. Though readily distinguishable microscopically from the typical bacillus coli there are many forms of the latter greatly resembling the bacillus typhosus. Cultivations grow in the ordinary nutritive media, and rapidly develop in milk, beef-tea, or butter. The bacilli are killed when exposed to a temperature of 60° C. for even twenty minutes, but several observers have seen cultures of the bacilli in beef-tea alive for weeks at a freezing temperature, and they preserve their vitality in ice.

They usually soon disappear from ordinary water, but have been found in it, as in the Maidstone epidemic of 1897.

They usually soon die in typhoid stools, but may remain alive for months in sterilised stools; experiments of Andrews showed they rapidly die out if planted in sewage.

They retain their vitality under suitable conditions for months or years, even when dried, which supports the supposition that the disease may be transmitted by dust.

Mode of Infection is mainly through the alimentary canal; and the most common carrier of the poison is infected drinking water from wells or streams, or pollution of a general system of water supply. Instances of epidemics which were clearly traced to the water supply are numerous, the latest example on a large scale in England being the Maidstone epidemic of 1897, in which the water supply of a certain area was contaminated by surface drainage. Many so-called "milk epidemics" are due to water used to clean the cans or to dilute the milk.

Milk is a favourable medium for the growth of the bacillus, and many attacks due to milk infection are recorded.

Food.—Oysters eaten raw may certainly act as carriers of the poison, and the germs have been found in them derived from the water in which they are fattened; epidemics have been described due to other shell-fish; the disease may be conveyed by vegetables eaten uncooked. There is accumulating evidence that the disease does affect other animals than man, and it is said that typhoid fever has been contracted through eating the flesh of animals suffering from typhoid fever.

Sewage Emanations.—It is probable that the gaseous emanations from cess-pools or drains infected with the typhoid virus may, if inhaled, produce the disease; for though sewer gases rarely contain typhoid forms, which probably perish in the presence of the other organisms of sewer contents, there is no impossibility that under special circumstances the typhoid poison may be contained in drain effluvia, and give rise to the disease.

Contagion.—There is undoubted evidence that under favourable conditions the disease may be transmitted from one person to another. Sir William Jenner attributed typhoid occasionally to the inhaling of the patient's breath by students closely watching the rise of the mercury in the clinical thermometer in the patient's mouth in the days before the instrument was provided with an index; but it certainly does not in this country spread far through the medium of the air; possibly in countries where dust clouds are common and where typhoid is epidemic it may be so conducted to a distance.

The stools and urine containing the infecting organism may transmit it; attendants on typhoid patients and those employed in washing the soiled linen occasionally contract the disease, especially if insufficient care is taken in washing the hands, and in efficiently disinfecting excreta and nursing utensils, and bedding contaminated by excreta.

The disease is said to be conveyed by flies and other insects. Proofs of this are wanting.

The poison enters the body in nearly all cases by the alimentary canal, for even if inhaled it may pass from the pharynx into the digestive tract.

In many cases it is quite impossible to trace the source of infection.

Age.—It has been observed in infants even as young as 4½ months, but it is not common before the third year; it is apt to be mild in children, and probably it occurs in children more often than is generally stated. In the Maidstone epidemic 22 per cent of the subjects were children. The period of greatest susceptibility is from 15 to 25 years; half the cases occurring in these ten years; after this it gradually decreases in frequency, and is uncommon after the age of 50, but has been observed even at the age of 90 years.

Sex.—There is little or no difference in the susceptibility of the sexes.

Family and Individual Tendency.—There is a marked idiosyncrasy to contract typhoid fever in some families, or to suffer severely from it; on the other hand there is said to be individual immunity. Though an individual may possess immunity at any moment, there is no proof that such immunity is perpetual; and in typhoid as in the other exanthemata an individual may go unscathed for years while exposed to conditions most favourable for contracting it, and contract it at a later period when such risks appear much less. The condition of bodily health here as in other diseases is a factor in immunity.

Condition of Health.—Perfect apparent health is consistent with the contraction of typhoid fever, but in my own observation it has occurred with a frequency after injuries and accidents too great to ascribe to mere coincidence.

Season of the Year.—It occurs chiefly in the autumn, and has been called autumnal fever; this is noticeable in America as well as in England; the period of greatest mortality is in October or November, the minimum mortality is usually in April. In autumns succeeding a very hot summer it appears particularly common. The varying prevalence at different seasons has been attributed to the sinking of the level of the ground water from the surface of the soil.

Immunity.—As already said, some individuals appear to possess an immunity against typhoid fever, though such immunity may not be a perpetual one.

There is a general belief that the disease protects against a second attack; this belief is founded (*first*) on the existence of records of outbreaks affecting almost every one in the house or locality, who has not already had the disease, and sparing those who had been attacked in a visitation years before in the same locality; (*secondly*) on the fact that few patients coming under observation with typhoid fever admit having had a previous attack; (*thirdly*) on experimental proofs that typhoid protects against subsequent attacks founded on the investigations of Widal, Kitasato, and others; guinea-pigs which had been infected by cultures of typhoid bacilli were more or less immune to the action of a stronger virus, and the blood serum of animals thus rendered immune conferred immunity on other animals. Relapses, however, are very frequent in typhoid fever, which to some extent argues against acquired immunity. Many persons probably who get typhoid while children cannot remember this when adults, and as a matter of fact persons are known to have two or even three or more attacks of typhoid fever. In the Hamburg epidemic of 2000 typhoid patients, 14 had had previous attacks, a proportion which, though cited as a proof of immunity, is by no means inconsiderable compared with the incidence of typhoid in the population generally. In the South African campaign numerous individuals suffered from more than one attack of typhoid fever, and there is no reliable evidence that typhoid fever confers marked immunity against subsequent attacks.

Morbid Anatomy.—The specific lesions of typhoid fever are mostly found in the intestinal tract, mesenteric glands, and spleen.

Small ulcers may occur in the mucous membrane of the pharynx and the *œsophagus.*

The *stomach* may show catarrhal changes, and rarely small ulcers or hæmorrhages.

In the *small intestine* the changes are chiefly in the lower part of the ileum, but may be in its whole length, and even in the jejunum and duodenum. The solitary follicles and Peyer's patches become hyperæmic, and the mucous membrane becomes reddened with increased mucous secretion. The hyperæmia subsides, and the follicles and patches become turgid and prominent, constituting pale elevations above the general surface of the intestine. The swelling is due to a great increase in lymphoid cells which even infiltrate the adjacent mucosa. The cells are for the most part nucleated, and there are other larger multinucleated cells; the lymphatic vessels are dilated, and contain proliferating endothelial cells; the blood-vessels are compressed. In many of the swollen follicles and patches the swelling gradually subsides, the contained cells becoming granular or fatty and becoming absorbed. Some of the follicles, especially in severe cases, become the seat of sloughs, soft yellow, or grey, and varying in thickness; the sloughs may involve the mucous membrane only, or all the muscular coat of the intestine; they are formed of granules, fibrin, corpuscles, and micro-organisms; the sloughing process appear due to the action of the typhoid and other micro-organisms.

Ulcers result from this sloughing process; these ulcers may be minute and circular from sloughing of the solitary follicles, or oval with their long axes corresponding to that of a Peyer's patch, and consequently to that of the intestine. The depth of the ulcer depends on the thickness of the detached slough, sometimes it is quite shallow; usually it extends into the muscular coat or deeply to the peritoneal coat. The ulcers are mostly irregularly oval, corresponding to a part only of a Peyer's patch. The edges of the ulcer are thin, undermined, usually ragged, and float out in water. The base of the ulcer is usually smooth after detachment of the slough. Sometimes the ulcers are serpiginous. Healing occurs by the formation of granulations in the floor of the ulcer, and the epithelium grows gradually over the ulcer from the edge and from a smooth cicatrix sometimes depressed with little, if any, contraction, and is recognisable for years after the typhoid attack. In the hyperæmic stage crowds of typhoid bacilli may be seen by staining and in the lymphatic vessels of the follicles.

There may be only one ulcer usually near the ileocæcal valve, or the ulcers may be very numerous; and the greater part of the mucosa of the last foot of the ileum may be a brown-black eschar; or the terminal 6 or 8 inches of the mucous membrane of the ileum may form a large ulcer in which here and there are islets of mucosa. Often ulcers are seen in the lower part of the small intestine, and hyperæmic and raised patches higher up in its length. Sometimes most of the ulcers have healed up before death occurs from other causes.

In about one-third of the cases the cæcum and colon are affected. The cæcum may have very large irregular ulcers within it; in some cases the colon is the seat of ulcers along nearly its whole length—small circular ulcers which occasionally perforate: this may occur where there are no ulcers in the ileum. There may be no ulceration from first to last, even in cases of long duration which come to the post-mortem table, and it may fairly be inferred that this is even more likely to occur in slight cases which never come to the post-mortem table. The vermiform appendix may be inflamed or ulcerated.

Perforation of ulcers occurs from the thinned wall of the intestine rupturing at the seat of an ulcer, or from a sloughing process; occasionally it occurs in a partly-healed, or even in a completely cicatrised ulcer.

Mesenteric Glands.—The glands swell from hyperæmia and cell infiltration; those glands especially are involved most directly connected with the ileum, and so too are the retro-peritoneal glands. The swelling subsides as the infiltrated cells get fatty and become absorbed, but the glands may soften or actually suppurate and rupture, producing peritonitis, sometimes fatal; there is sometimes considerable gland enlargement with very little intestinal ulceration. The presence of typhoid bacilli in the mesenteric glands is almost constant.

The Spleen is nearly always enlarged, and may, in late stages, weigh as much as 20 ozs., and be 3 or 4 times the normal size; it is relatively most enlarged in children. The capsule is tense, and the pulp dark and soft with undue distinctness of the Malpighian bodies. Infarcts or abscesses may form in it which may give rise to rupture or to suppurative peritonitis. Typhoid bacilli are nearly, if not always, to be found in the spleen.

The Liver may be enlarged and pale or hyperæmic, the liver-cells may be granular. The biliary ducts are often inflamed, and also the gall-bladder, which may contain pus or its wall be gangrenous. Aggregations of typhoid bacilli are nearly always detectable in the liver, and the bacilli are often present in the gall-bladder.

The Kidneys.—Cloudy swelling of the epithelium of the cortical tubes, or signs of acute hæmorrhagic nephritis, or infarcts or microscopic abscesses may be present. The typhoid bacilli are found only exceptionally in the kidneys.

Heart.—The myocardium may be pale and soft with granular or fatty changes, or the "myocardite segmentaire" of Renaut.

Endocarditis and pericarditis are rare. Typhoid bacilli have been found in the myocardium and in the vegetations on the valves.

Blood-vessels.—Arteritis, and more commonly phlebitis, with typhoid bacilli in the walls of the vessels, occur and give rise to thrombosis, and may be gangrene.

Respiratory Organs.—The changes in the respiratory organs are indicated by the various affections described under the head of "Complications." The specific bacillus may be discovered sometimes in the lungs, but it is much more common to find other micro-organisms.

Nervous System.—The symptoms of nerve disturbance in typhoid fever are more often due to toxic blood conditions than to organic disease, but meningeal inflammation, cerebral softening, and peripheral, or spinal cord changes may occur, and are described under the head of "Complications."

Muscles.—Hyaline degeneration of muscles occurs in typhoid as in other fevers, and it sometimes leads to rupture of muscles and consequent hæmatomata or abscesses.

Bones.—The changes in the medulla and periosteum of bones are not special to typhoid fever, but the typhoid bacillus is not infrequently found in the pus in abscesses in these structures.

PATHOLOGY.—The bacilli, for the most part, gaining entry into the body by the alimentary canal, invade the lymphatic tissues beneath the mucous membrane of the intestine, and pass through the mesenteric glands into the blood, spleen, and other organs. It is to the poison resulting from the bacilli, the exact constitution of which is not known, that are due most of the symptoms of typhoid fever. The poison is, for the most part, intracellular, and in the bacilli themselves, filtered cultures being of little power; but there is evidence that the toxins from the bacilli may diffuse into the culture medium or into the fluids of the body. The typhoid bacilli are themselves pyogenetic, but many of the local lesions and the toxic symptoms are producible by other micro-organisms, the growth of which becomes more active in presence of the typhoid bacillus. Various organisms take part in this mixed infection, chiefly the streptococcus, the staphylococcus pyogenes, the bacillus coli communis, and the pneumococcus. The chief poison produced by the typhoid germ appears to be an albuminoid, and has been called typhotoxin. Speculations have been published as to difference in the symptoms produced by the products of the typhoid, and of other bacilli in the blood; most often, probably, the symptoms are due to mixed toxæmia.

Dr. Alexander Paine, of St. Mary's Hospital, has kindly written on "The Serum Diagnosis of Typhoid," as follows:—

The action which the blood of individuals suffering from typhoid has on cultivations of the typhoid bacillus is a valuable aid in the recognition of that disease.

If the serum of the blood of a patient suffering from typhoid is added to a young broth-culture of the typhoid bacillus, the organisms lose their motility, aggregate in clumps (agglutination), and ultimately settle to the bottom of the liquid as a sediment, leaving the supernatant fluid clear. If the serum from a case other than typhoid is added, the bacilli remain actively motile, there is no sedimentation, and the fluid retains its turbidity.

This property of agglutinating organisms which the blood acquires in disease has been under consideration for many years. Its application to the diagnosis of this disease was made by Widal in 1896, hence it is known as Widal's Reaction.

The reaction appears as early as the seventh day, or even earlier; it lasts throughout the course of the disease, and may be obtained for an indefinite period after convalescence is established, often many months.

Other fluids of the body possess this property of agglutination, a reaction may be obtained from the milk, tears, and urine of typhoid patients, also from the fluid of blisters and other serous effusions. Drying of the blood does not destroy this power, though it diminishes it.

In a small percentage of cases (3 per cent) of individuals suffering from typhoid the serum fails to agglutinate the bacilli; but all cultures of the organisms do not react equally to typhoid serum—not only are there different species of the organism, but in the same species varying conditions of growth may alter its characters in this respect.

Since a reaction, though incomplete, may be given by the serum of a patient not suffering from typhoid—and even by the serum of a healthy individual if it is present in too large a quantity—it has been found necessary to dilute the serum when testing its agglutinative power. Low dilutions are not reliable for this reason; on the other hand, with an excessive dilution a typhoid serum with feeble agglutinative power may fail to give the reaction.

Various dilutions are used, but it is generally held that with a dilution of one in thirty there is a minimum of risk.

Application of the Test.—A small quantity of blood taken (with every precaution to avoid contamination) from the ear or finger of the patient is drawn into a capillary tube and allowed to clot. The serum which separates may be tested in the following manner:—

1. *Microscopically* (*rapid method*).—The serum is diluted with normal serum or normal saline by means of a graduated capillary pipette or a sterilised platinum loop, till half the required dilution is obtained.

A loopful of the diluted serum is added to a loopful of a 24-hours-old culture of the typhoid bacillus in neutral Bouillon, and the mixture examined under the high power of the microscope by the hanging-drop method.

If the patient is suffering from typhoid the organisms will become motionless and adhere together in clumps. This may take place immediately, but it usually requires from a few minutes to half an hour for the agglutination to be complete. Under exceptional circumstances it may be delayed for one or two hours.

If the patient is not suffering from typhoid the organisms remain actively motile for hours, and do not form clumps.

2. *Microscopically* (*sedimentation test*).—This method, although it requires longer time for its completion, has the advantage that it can be observed with the naked eye.

The dilution of the serum and its addition to the bacterial culture can be most accurately made in the straight capillary tube suggested by Wright. The serum is drawn up to a fixed mark on the capillary tube and blown out into a glass capsule. Normal serum or normal saline is next drawn up to the same mark a number of times in succession, and mixed with the serum until half the number of dilutions is obtained.

Equal quantities of this mixture and a 24-hours-old broth culture of the typhoid bacillus is aspirated into a bulb at the upper end of the tube, and, after well mixing, is blown out in one long column into the capillary tube, the end of which is sealed off.

A control tube containing an equal quantity of the bacterial culture and normal serum or normal saline is made in the same manner.

The two tubes are kept upright for 12 or 24 hours — at the end of that time, if the serum is taken from a patient suffering from typhoid, the fluid becomes clear—the organisms forming a flocculent sediment at the bottom of the liquid. The fluid in the "control" remains uniformly turbid, and there is no sedimentation.

SYMPTOMS

Incubation Period is the interval between the moment of infection and of the invasion. Each of these events is so often indefinite that in many cases it is not possible to exactly determine the duration of the incubation period; most commonly it is from eight to ten days, but it may be only one or two days (very rarely), or as long as twenty-three days.

There are seldom symptoms during the incubation period, but headache, loss of appetite, sense of fatigue, or sleeplessness may occur.

Symptoms of Invasion.—The invasion is usually gradual; the most constant and earliest symptom, in fact the symptom from which is usually dated the invasion, is *pyrexia*. The temperature rises first in the evening 1·5 to 2°, and on each succeeding day increases by 1°, the evening temperature maintaining the excess of 1·5 or 2° which it gained by commencing to rise before the morning temperature; after four, five, or six days of such step-like ascent the temperature stands at 101° to 103° in the morning and at 103° to 105° in the evening; the evening temperature then ceases to rise, but the morning temperature rises one day later than the evening (having commenced a day later), and there results a morning temperature of 102° or 103° or 104° and an evening temperature of 103° or 104° or 105° according to the severity of the attack.

Exceptions to this gradual mode of rise occur. Not very uncommonly the rise of temperature is abrupt, reaching 103° or 104° in the first twenty-four hours. Sometimes, especially in children, the temperature may, though daily increasing, drop to normal during some part of each day, and in very rare cases the invasion has been without pyrexia, as has the whole course of the disease.

Headache usually comes on early, slight or of any degree of severity; usually frontal, rarely occipital or all over the head, or it may extend down the neck; a tensive dull pain with sometimes acute paroxysms; it usually lasts through the invasion period into the real period, but may cease earlier. *Convulsions* are very rare.

Epistaxis occurs in about half the cases, once or repeatedly, slight or considerable.

Chills rarely, rigors may occur; *deafness* may be an early symptom.

Discomfort, rarely pain, tenderness, and gurgling in the right iliac fossa may occur, and *laxity of bowels* is common. There is usually a feeling of languor and weakness, and the patient thinks he has "caught a chill" or got a "bilious attack."

Tonsillitis may be an early symptom.

The onset instead of being gradual may be very abrupt, with sudden pyrexia, nausea, repeated vomiting, and pains in the abdomen, simulating acute peritonitis or gastritis. Or it may begin with high fever, chills, profuse sweats, headache, and signs of severe bronchial catarrh, simulating acute tubercular phthisis.

Other cases begin with symptoms and signs—apical or basic—of acute croupous pneumonia. Some such cases are due to the bacillus typhosus, and have been called "pneumotyphoid."

Again the initial symptoms may be severe headache, vomiting, high fever, retraction of head, vomiting, convulsions, and delirium. Usually these symptoms soon subside, being toxic only; but in others they persist and are due to actual meningitis, other signs of which, such as squint, paralysis, become evident later. The bacillus typhosus is accountable for some such cases which have been called "cerebral typhoid."

Occasionally the disease begins with acute maniacal delirium or with "confusional insanity," marking other evidences of the disease, and such patients have in consequence been sent to asylums.

In a few cases typhoid begins with symptoms of acute nephritis with blood and albumen in the urine, and other evidences of typhoid become marked later. These cases have been called "nephro-typhoid."

And cases are described by Salamon beginning with acute pleurisy due to infection of the typhoid bacillus—pleuro-typhoid.

Symptoms of the established disease are continuous with those of the invasion, gradual or abrupt as the case may be: the diarrhœa and headache continuing, the patient becoming more languid and weak, and eventually taking to bed at a date depending on the severity of the attack, the disposition of the patient, and the advice he receives or follows. When the onset is abrupt he may take to bed at once, but more often it is only after three or four days or a week, when the disease is suspected rather than diagnosed, sometimes much later when he is quite exhausted, and in the "latent" form he may keep about, even after perforation has occurred.

Alimentary Canal.—The tongue, at first moist and slightly furred, tends to gradually get more thickly coated, and after fifteen or sixteen days may get dry brown, baked, or even fissured, sometimes bleeding. If the temperature does not fall after about twenty-one days, tenacious exudation may collect around it, and it becomes difficult of protrusion; in general it tends to become dry much in proportion to the amount of diarrhœa. The tongue usually begins to clean and become moist as the temperature falls and convalescence comes on, but it may do so much earlier, cleaning entirely at the end of eight or ten days, though the disease runs on for the usual period. The tongue may be clean throughout even in fatal cases. Sometimes it becomes glazed and smooth.

Sordes are apt to occur on teeth and lips, which are often sore and bleed from picking.

Herpes on the lips or face is very rare without pneumonia or rigors.

The *pharynx and palate* may in severe cases become coated by a whitish exudation like thrush or diphtheritic membrane, and containing chiefly streptococci and staphylococci.

The breath has usually a *characteristic odour* even early in the disease; *thirst* is common, especially when pyrexia or diarrhœa or melæna is severe. *Anorexia* comes on early, lessening with defervescence, and before there is apyrexia the craving for solid food may become very great. Hydrochloric acid is deficient in the *gastric juice; nausea and retching* may, as already said, be initial symptoms, or they may come on later from peritonitis with or without perforation, from uræmia or other causes; the stomach is apt to become much *distended* from the liquid diet, recumbent position, and impaired digestive processes.

Tympanites is usually little marked during the first few days, and may be moderate throughout, or may become extreme, gradually or suddenly. Sometimes the tympanitic belly is tense and drum-like; in other cases is soft and doughy, muscle tonus being apparently lost from toxæmia of the nerve centres. Tympanites is usually greatest when diarrhœa is severe (Hare finds the reverse). With subsidence of the disease the tympanites subsides; but the belly may become retracted when the patient is becoming exhausted (intestinal distension is often simulated by distension of the urinary bladder or of the stomach).

The "*bell sound*" may occur over parts of much distended colon. When general over the whole abdomen it indicates perforation of intestine.

The iliac fossa is often the seat of discomfort and tenderness, rarely of much pain. Sometimes *severe pain* is felt about the iliac region, indicating deep ulceration, and in many cases points to ulceration of the large intestine (severe pain may occur in the lower part of the belly from retention of urine).

Gurgling in the iliac fossa is common, but is not special to enteric fever.

Respiratory movements are often noticeably lessened over the lower part of the abdomen on the right side.

The *bowels* may be greatly relaxed, the motions being as many as twenty-four in the twenty-four hours, or there may be constipation throughout. Often they are relaxed at first from the administration of purgatives, and afterwards constipated, or the reverse may occur. Diarrhœa is certainly much less frequent now than Murchison's estimate some years ago of 95 per cent of cases. Osler found it in 30 per cent of his cases. In the Maidstone epidemic it occurred in half the cases. Hare finds constipation more often than diarrhœa. It appears to vary in different epidemics, and is certainly lessened by early and careful dieting. Murchison doubted any relationship between the amount of diarrhœa and the severity of the intestinal lesion, and certainly constipation may be associated with deep ulceration; but in general, when intestinal ulceration is slight or absent diarrhœa is at its minimum, and when there is extensive ulceration there is almost always diarrhœa. The stools are unformed even though there is no diarrhœa. They may be at first dark, but soon become light yellow in colour (occasionally green, like chopped parsley), liquid, and offensive. They separate on standing into a deposit of debris of food, epithelium and biliary constituents, with a supernatant alkaline and albuminous clear fluid. The bacillus coli and bacillus of Eberth are found in them. At any time after the first eight or ten days they may contain shreds of larger portions of slough, sometimes with intestinal muscle fibre. Blood may be passed early from congestion around Peyer's patches, or later on from open ulcers (*vide* Complications). There is a tendency to involuntary passage of fæces, accounted for often by the liquid nature of the stools, and the abdominal distension, together with the mental hebetude; sometimes from complete unconsciousness or from paralysis of the sphincter.

The *spleen* may enlarge, sometimes very greatly, rarely sufficiently to ascertain clinically for the first week or so. The outline is sometimes easily felt, and in thin children may project the abdominal wall. It appears to vary in size from time to time, and its percussion dulness varies with the distension of the colon. Even when no enlargement can be detected its position is often tender on pressure. It may remain large some time after the temperature has fallen to normal, and it usually enlarges during relapses or exacerbations. Infarcts and abscesses may occur in the spleen (*see* Complications). The typhoid bacillus is obtainable from the spleen by puncture.

Under the name "spleno-typhoid" Eiselt describes cases in which the spleen is the chief organ affected, and intestinal symptoms are absent. In some of these cases the spleen becomes of enormous size, and there is pyrexia of a relapsing type.

The pulse is usually quickened from the first, being usually 85 to 100 per minute in males, and 100 to 120 in females (Dreschfeld). Its maximum in 100 cases of Murchison's was 110 to 120. It varies in frequency at different periods of the day, and is readily accelerated by slight causes, mental emotion, etc. Attacks of typhoid occur in which the pulse is slow throughout. As the temperature falls with the subsidence of the disease the pulse rate falls also; but in bad cases, when the fall of temperature is only temporary, the pulse rate often keeps up. The pulse is usually dicrotic and of low pressure from the first, but this character may be quite lost in late stages. In long lasting cases the pulse tends to get more and more feeble, and running or thready, and its beats become very rapid or uncountable (150 or 160 per minute). When hæmorrhage is about to occur it usually gets rapid, short, and irritable.

In late stages the pulse is apt to become irregular or intermittent, especially in children, and during convalescence it may become very slow, as is the case in other exanthemata, and influenza.

In some cases of typhoid the pulse is very feeble from the first, and there is blueness of finger ends.

There is nothing peculiar to typhoid in the character of the heart sounds. They tend to become weak as the heart progresses, and, it being a long lasting fever, with many conditions contributing to toxæmia and to drains on the tissues of the body, the action and sounds of the heart may become extremely weak; but typhoid mostly affects persons who are young and in whom the heart has reserve force enough to carry them through the longest and most severe illness.

Syncopal attacks, even fatal, may occur during convalescence, and in some such cases little structural change has been found in the heart substance. They are probably attributable as much to want of blood in the body as to loss of heart power.

Blood in Typhoid Fever.—The red blood corpuscles in the late stages are much decreased, falling to even 2½ million per cmm., and the hæmoglobin is correspondingly lessened. The leucocytes also become much lessened in number, sometimes numbering only 1000 per cmm. (Huyens). This decrease is most marked in the late stages of the disease. According to Coe the fibrin of the blood is diminished in typhoid fever, the exact contrary of what occurs in other fevers. The blood plates are diminished in number.

All these results show the deterioration of the quality of the blood in typhoid fever, and there is in the disease a progressive anæmia. The actual volume of the blood becomes lessened; and especially when there has been much diarrhœa, sweating, and hæmorrhage, the vessels become extremely empty. In many cases, as will be found in opening veins for injection of salines, the veins are over full and the arteries quite empty. The tendency to bloodlessness in severe typhoid cases is an important point to be remembered in treatment. Fatal results attributed often to cardiac failure are really due to blood failure.

Epistaxis may occur not only during the incubation period, but later on, even as late as the twenty-ninth day (da Costa). It may then be a part of a tendency to general hæmorrhages from the mucous membranes (*see* Complications).

Respiratory System.—The respirations are accelerated by the pyrexia and blood condition. At the onset of the disease moist sounds are usually audible in the larger bronchial tubes, and later on there is a tendency to hypostatic congestion of the lungs. In some cases more severe affections of lung or pleura occur (*see* Complications). As already said, typhoid fever may begin with acute pneumonia due to the bacillus of Eberth (pneumotyphoid) or more rarely with pleurisy (pleuro-typhoid).

Renal System.—The urine is lessened in quantity and febrile in character; during convalescence the quantity is often increased and phosphates deposited. Albuminuria occurs in about one-quarter of the cases, usually slight in amount, and due to pyrexia and to toxins in the blood, rarely to the typhoid bacillus; the urine may be very offensive.

Typhoid bacilli are detectable in the urine in about 25 per cent of the cases, not often before the twelfth day, sometimes in quantity sufficient to produce turbidity of the urine. It is probable that bacilli pass through the kidney into the bladder, and there multiply to produce this condition, and *retention* of urine, which is extremely common in typhoid fever, may favour this process. Other renal complications are described under that head.

Ehrlich's Reaction.—Ehrlich's test depends on the production of a pink colour and froth when the urine of a typhoid patient is treated with his solutions. These are two in number (1) acid hydrochloric one part, distilled water twenty parts, sulphanilic acid to saturation, (2) a half per cent solution of nitrite of sodium in distilled water. The test consists in adding to a specimen of the urine an equal quantity of liquid made up of the two solutions in the proportion of forty parts of No. 1 solution to one part of No. 2 solution, and then adding liquor ammoniæ to alkalinise the solution. In cases of typhoid fever the urine becomes of a deep ruby-red colour, and on shaking the test-tube a delicate pink froth is produced. It is not claimed this pink froth is produced only in the urine of typhoid fever, but it is very constant in such urine.

Nervous System.—The degree of affection of the nervous system varies with the character of the epidemic, the intensity of the poison, the idiosyncrasy of the patient, the condition of his secreting organs, and the associated secondary infection. It is rare for the patient to be suddenly prostrated by the onset of typhoid fever as by typhus fever or influenza, but this may occur especially in children. Most often the early nerve symptoms are headache, sleeplessness, and lassitude; the headache usually lasts the first ten days, but it may persist longer, sometimes coming on again late in the disease; the sleeplessness usually passes off with the headache and gives place to undue drowsiness. The mental condition may remain clear throughout even a long and fatal case, more often there is some degree of hebetude, with slowness of apprehension and delay in speech, though what is said is quite reasonable. In some cases the mind seems unusually active, the patient answering questions and volunteering information with great minuteness of detail. Often with a tendency to drop into heavy sleep, the patient is perfectly clear when roused. Delirium occurs in many cases, varying from a little "lightheadedness" at night to loud, noisy, very active, or low muttering delirium. Sometimes it resembles delirium tremens. Delirium does not often occur before the tenth day, that is, after cessation of the headache; the two together are rare; it may occur early, even on the very first day. Delirium may occur in cases with little intestinal disturbance, in fact in some cases toxic nervous symptoms predominate over all other symptoms. In cases which go on after the twenty-fourth day or thereabouts, delirium is rarely absent, in many cases it comes on with septic complications, especially pneumonia; in some is a symptom of local intracranial disease (*see* Complications). It may come on during convalescence, like acute mania; sometimes acute maniacal attacks alternate with perfectly quiet intervals. In severe cases stupor or actual coma occur, and in some cases there is coma vigil or coma with wide-open eyes and constant movements of hands or tremor of limbs.

A condition of trance may occur or of temporary aphasia; in some a dazed state due apparently to loss of memory of where they are or who is attending on them, and often when the disease is over there is no recollection of anything that occurred. The pupils may be dilated in typhoid fever, but they are very often not so, and may be contracted.

Deafness may be one of the earliest symptoms of typhoid, or come on at any time in the disease. Sometimes it is due to administration of quinine, sometimes to middle ear disease, but most often appears to be a purely nervous affection.

Tremor of tongue is mostly present, often also of limbs; both may become extreme. Much tremor is often associated with deep ulceration, but it may occur from toxæmia only. Subsultus tendinum or "carphology" may occur in protracted and severe cases, and may become associated with coma vigil, the patient lying in a stupor with open eyes—a condition mostly fatal.

The deep reflexes are often but not invariably increased, and may be absent even without peripheral nerve changes. Convulsions may initiate the disease in children but are rare in adults except from uræmia or meningitis. (For other nervous phenomena see Complications.)

General Symptoms.—There is nothing characteristic in the early period in the general aspect of the patient, but with the continuance of the fever there is a dull, heavy expression, especially when the headache is severe. The *decubitus* is usually dorsal, but children especially, and even adults, may lie on either side—in later stages the patient tends to sink deep into the bed. There is often a suffused look about the face, which may be pale or the cheeks may be flushed. In well-nursed cases and where diarrhœa or complications are absent, there may be little loss of flesh, but the emaciation in severe cases is extreme, with haggard face and sinking eyes. The daily loss of weight has been estimated at from two to seven ounces per diem. Children especially rapidly emaciate. The skin may be pungent, hot and dry, or there may be profuse sweats, even though the pyrexia is severe. It is said a peculiar semi-cadaverous odour emanates from the skin. I have noticed it only in cases with septic complications.

The eruption is present in a large proportion of cases. It consists of lenticular spots of delicate pink colour, about 2 to 4 mm. in diameter, very slightly raised, with margin shading into surrounding skin, fading on pressure. They may be slightly vesicular, they rarely appear before the eighth day of the disease. Each spot develops in a few hours, and lasts individually four or five days, fading gradually. They come out singly or in crops, varying in number from two or three to some hundreds. They chiefly appear on the back, or surface of chest or abdomen. Fading on pressure, they are not immediately visible on the back after the patient has been lying in the dorsal position, but become visible a few moments after he turns on his side. They are rarely seen on the limbs or face. In some cases the spots are deep purple in colour, though still disappearing on pressure. Sometimes they are actually hæmorrhagic; typhoid bacilli have been obtained from the spots. Very often before the true typhoid eruption or with it there come out numerous "typhoid blotches," carmine in colour, considerably raised above the surface, irregular in shape, and very much larger than true typhoid spots.

Chills or actual rigors may occur at the onset, or during the course of the fever (*see* Complications).

Temperature in Typhoid Fever.—In most cases the temperature rises a couple of degrees on the first evening, and for the next three or four or five days there is a daily increase of temperature of 1° compared with the temperature at the same time on the previous day. By this step-like ascent the temperature stands at about 102° in the morning and 104° in the evening of the fifth day, and the morning temperature continuing its increase a day later than the evening temperature, there results a temperature of 103° in the morning and 104° in the evening. Then ensues a period which has been called the fastigium, lasting till the commencement of the decline of the disease, in which the temperature continues at this level (sometimes rather less, sometimes more). The duration of this period is about twelve days, and the morning temperature then remits a degree or so, and falls back 2° below the temperature on the same evening; both morning and evening temperatures thus fall day by day each about 1°, till by the twenty-first day the normal is reached in the morning, and in a day or so later also in the evening. Then ensues a period of convalescence in which the temperature should be 1° or 2° below the normal for a few days, till with returning strength it again rises to normal.

The commoner variations in the course of the pyrexia are as follows:—

1. The temperature may rise abruptly with the invasion, reaching 104° or higher in the first twenty-four hours, and the fastigial stage begins at once.
2. The pyrexia may gain a degree daily, but may fall to normal at some time on each (or some) of these days.
3. The fastigium may continue much longer than the average of fourteen days, very frequently another six or seven days, sometimes as long as fifty days.
4. The fastigium may be of much less than the average duration, the morning remission occurring after even four or five days, and apyrexia being attained by the twelfth or fourteenth day (abortive typhoid); in some cases the early termination may be by crisis.
5. There may be sudden, extensive, irregular rises or falls in the temperature; these may be due to complications, such as pneumonia, or hæmorrhage, or perforation, or septic absorption, or to slight excitement or to nerve disturbance. In some cases the irregularity in temperature is extreme, and without ascertainable cause other than to toxic disorder of the heat-regulating centres.
6. Hyperpyrexia may occur up to 110·3° in fatal cases, or to 107·8° consistently with recovery. It is in nearly if not all cases due to local complications and septic absorption.
7. The temperature may be intermittent throughout the disease.
8. It may remain normal or subnormal throughout the disease; such afebrile typhoid has been observed in epidemics, and is not less serious or free from the dangers of typhoid fever than other forms.
9. Occasionally the temperature may be higher in the mornings than the evenings.
10. The fall of temperature with cessation of the disease may be by crisis.

Course of the Disease.—The disease is very generally divided, for purposes of description, into periods or stages corresponding to epochs each of seven or of ten days' duration; but there is no anatomical or clinical ground for such division. The period at which ulceration of intestines begins varies within wide limits, and even if it did not, its commencement is unmarked by any recognisable symptom. The cutaneous eruption appears at very varying dates in different cases. The period of continued fever or fastigium is no constant duration, and there is no special change on the seventh day or on any multiple of the seventh day, nor is there any crucial day on which the disease is apt to end, though this often occurs about the twenty-first or twenty-eighth days. Such an idea appears to be a vestige of the time when typhoid and typhus fever were regarded as one disease, and spoken of as seven-day fever.

By a consideration of the history of the illness taken with the symptoms we can usually tell approximately about how many days the disease has lasted, and divisions into weekly stages are artificial and useless.

It is convenient to describe the invasion symptoms separately from those of the established disease, but as already noted there is no defined line between these periods. As the disease progresses the condition of tongue becomes worse as a rule, the pulse-rate quickens, the patient weakens and loses flesh, and the mind usually becomes more confused; symptoms, too, may be added due to complications.

The great majority of cases recover, the temperature gradually falling to subnormal, the stools becoming formed, and other symptoms subsiding till convalescence is established.

The duration of the disease varies considerably. As already mentioned it may abort, the symptoms and pyrexia subsiding after about ten days, possibly even earlier; but the diagnosis of a case of typhoid which aborts before the period at which the characteristic symptom appears must necessarily be open to doubt.

The average duration of 200 cases, which recovered, collected by Murchison, was 24·3 days, and over three-fourths of them lasted more than three weeks; there was no evidence of any critical day on which cessation most often occurred, though it was often *about* the twenty-first or twenty-eighth day. In exceptional cases the duration may be as long as sixty days.

In a minority of cases death occurs—from asthenia and bloodlessness, from toxæmia, from heart failure, or as a result of the many complications which are apt to occur.

Though we may thus separate the causes of the fatal issue, they are not infrequently combined in practice; and many of the deaths resulting from typhoid fever are not due to the typhoid poison but to septicæmia consequent on infection by other organisms.

Statistics show that about 35 per cent of the deaths are due to local complications, the most important of which are melæna and perforation of intestine; the remaining 65 percentage of deaths are attributable to more general causes.

When the disease is long protracted the temperature is apt to become irregular in the late stages, the circulation to become feebler, and the patient to sink gradually from toxic coma, with faint, flickering pulse; extreme tremor of limbs, face, and tongue muscles; blueness of extremities, and rambling delirium, with all the evidences of the typhoid state and extreme irregularity of temperature range. In other cases the mind may remain fairly clear and the heart force may fail, and death occur from syncope—a very rare termination in typhoid. When death is due to local complications the special symptoms arise described under that head.

Sudden death may occur from myocarditis and unexplained causes.

Death rarely occurs in typhoid fever before the fourteenth day—the average duration of Murchison's *fatal* cases was 27·6 days. Hoffman found it to be 28·9 days.

Very rarely death occurs quite early, even on the second day.

COMPLICATIONS AND SEQUELÆ.—*Digestive System.*—*Ulcers occur on the pharynx* (Bouvert); sharp-cut ulcers may also occur on the palate and on the pillars of fauces, due to the streptococcus and staphylococcus.

Acute glossitis; also *gangrene of tongue* may occur.

Cancrum Oris is very rare; said to be commonest in children. It may invade the cheek, gums, and alveolar process of jaw, and is a serious but not necessarily fatal complication.

Parotitis is uncommon, is usually unilateral, occurs as a late complication or as a sequela, attributed to spread of inflammation along Stenos duct or to metastatic inflammation; rather over half the cases are said to suppurate, and pus may escape through the meatus auditorius externus; the specific bacillus has been found in the pus. The entire gland may slough out. Thrombosis of the internal jugular vein may be produced and pyæmia. It is a serious but by no means fatal complication; the symptoms are those of parotitis from other causes, and the treatment is the same.

The œsophageal mucous membrane may be inflamed, and ulcers may form leading to stricture; submucous abscesses may occur.

Hæmatemesis is very uncommon, and probably arises from small ulcers or erosions of the mucous membrane; it may be fatal, as in a case under the author's observation in a young child.

Hiccough is sometimes obstinate; it may be due merely to flatulence, but if severe and persistent, suggests peritonitis or gangrenous changes in the intestine.

Peritonitis may result from deep intestinal ulcers without (or oftener) with perforation, from rupture of softened mesenteric glands, from splenic infarcts or abscesses, from rupture of gall-bladder, or of abscesses in the abdomen. It is indicated by its usual symptoms, preceded by symptoms special to the cause in the individual case. It may be localised and subside, or be rapidly spreading and soon fatal: the symptoms may be quite latent.

Perforation occurs in about 3 per cent of cases, accounting for about 18 per cent of the deaths from typhoid. It is most apt to occur in protracted cases with much diarrhœa or tympanites; melæna and pain in the abdomen, pointing to deep ulceration, often precede perforation. It is predisposed to by purgation, enemata, vomiting, sudden movements of the patient, by fighting the disease without going to bed, and by taking solid food too early.

It occurs as early as the eighth or as late as the hundred-and-tenth day, is uncommon before the fourteenth or sixteenth day, and is commonest between the twentieth and twenty-eighth days. It may occur during a relapse, during convalescence or long after convalescence appears completed. The perforation is usually in the ileum, rarely in the jejunum, occasionally the colon or the vermiform appendix; it may be a mere pin point hole in the thinned intestinal wall or an actual sloughing of the floor of an ulcer. Usually there are ulcers in the intestine which are nearly or actually perforated, as well as that which has actually perforated.

The symptoms of perforation are equivocal in some cases, being those producible by other complications likely to happen in typhoid, and on the other hand they may be so slight that perforation is not even suspected.

There may be sudden acute abdominal pain with subsidence of previous tympanites, sudden fall in temperature and pulse force, faintness, pallor, vomiting, clammy sweats; death may very quickly occur; more often the patient rallies and peritonitis sets in, with shivers or rigors, recurrence of pyrexia, vomiting, increased distension of abdomen, rapid pulse, followed by hiccough, rambling delirium, sunken features, sipping breathing, and death from exhaustion and sepsis in two to twenty-one days, usually in four or five days.

When the intestine gives way by some small pin-point hole, the mutual pressure of distended coils of gut may prevent the escape of intestinal contents, except perhaps a little oozing. In rare instances local peritonitis may seal up such perforation and lead to recovery; more often local abscess forms with septic absorption and fatal results. In cases of perforation such as these, the symptoms may be of the slightest: merely a slight fall in temperature and a feeling of faintness; later on rigidity of abdominal muscles, pain, and symptoms of peritonitis, but the more prominent symptoms are usually those of septic absorption, rigors, high fever, hiccough, etc.; such cases may last longer than those in which there is diffuse peritonitis, but eventually die of toxæmia.

Intestinal Hæmorrhage occurs in a proportion of cases variously estimated at from 3 to 9 per cent. The statistics of the Hospitals of the Metropolitan Asylums Board provide by far the greatest total of cases from which an average can be deduced and place it at about 10 per cent.

It may occur as early as the fifth or sixth day from congestion of the vessels around a Peyer's patch, but *severe* hæmorrhage does not occur till ulcers have formed, *i.e.* before the tenth day or thereabouts. It may occur at any time after this, most often between the twentieth and twenty-eighth days (or, according to Osler, between the fourteenth and twenty-first days); it usually arises from an opened arterial twig, sometimes from a vein.

The quantity may be a mere streaking of the motions or as much as several pints, bright red or dark coloured, in sudden rushes or gradual oozing, with or without clots; is often repeated again and again.

It is commoner in cases where there has been diarrhœa than where there has been constipation, and in cases where pain has been complained of. It may occur in apparently slight, but is more common in severe, and especially in protracted cases.

There may be no warning of even severe melæna; a sudden drop in temperature may precede it, or accompany it, or follow it. The fall in temperature may precede the melæna, probably occurring at the time of the escape of blood from the vessels, though this blood may not be voided for some hours later. Copious hæmorrhage may occur without any remission of pyrexia, and in any case it usually soon rises again after the hæmorrhage. Repeated or copious bleedings are followed by anæmia, prostration, pallor, and quickened pulse rate.

The mortality in cases of hæmorrhage has been estimated at from 30 to 50 per cent of the cases. Even when not the direct cause it is a powerful contributory cause of death, by draining away blood from the patient and predisposing to toxæmia.

Mesenteric Glands may soften and burst, setting up peritonitis; recovery or death may follow. The symptoms are often indistinguishable at the onset from those of perforation of the intestine, and probably some cases of supposed perforation and recovery were of this nature.

Fungel records perforation of the superior mesenteric artery by a suppurating mesenteric gland.

Splenic Infarctions are not very common, they may lead to abscesses which extend to the surface, and with or without bursting set up peritonitis and septicæmia. *Rupture* of spleen is recorded. *Hypertrophy* of spleen may follow typhoid.

Ascites I have seen in one case; it cleared up.

Appendicitis.—The cases in which a true typhoid ulcer has been found in the appendix are few, but occasionally appendicitis does occur in typhoid fever; and Hof found eight cases of perforated appendix in 808 fatal cases. Sometimes abscess occurs around the appendix, and bursts externally.

There is some, though not very certain evidence, that typhoid fever may account for appendicitis occurring long afterwards.

Persistent Dysenteric Diarrhœa may be a sequel of typhoid, sometimes it is due to serpiginous ulcers round the intestine.

Cicatrisation of Ulcers with constriction of the gut is a rare sequela of typhoid.

Liver.—A few cases of solitary abscess of liver due to bacillus coli, rarely to bacillus of Eberth, are on record, even fewer cases are known of multiple abscesses; these are of pyæmic origin from abscess elsewhere. Cases of suppurative pylephlebitis are recorded.

Cholecystitis.—The bacillus coli and the specific bacillus are frequently to be found in the gall-bladder, the latter Chiari, indeed, believes rather as the rule than the exception; it has been found in the gall-bladder as long as fourteen years after the typhoid. It may give no symptoms but, sometimes cholecystitis results and empyema of the gall-bladder, forming a large tumour with or without jaundice, which may perforate and prove fatal; three such cases have been operated upon successfully. It is believed that the bacilli of Eberth in the gall-bladder may be the starting-point of the formation of gall-stones.

Jaundice may arise in typhoid from catarrh of the bile ducts, or from toxic changes in the liver-cells of the nature of acute atrophy, or from cholecystitis or cholangitis; the streptococcus pyogenes and the bacillus coli have been found in the biliary ducts.

Circulatory System.—Endocarditis, with the specific bacilli in the vegetations occasionally, pericarditis still less commonly occurs. The *myocardium* is commonly soft, friable, and pale yellow, with fatty or parenchymatous change. Extreme softening of heart muscle is rare, and even in cases in which death has been attributed to syncope, the heart fibres may show little change; some such deaths are due to *intracardiac thrombosis* or to thrombi or emboli in the coronary arteries; some are due to extreme bloodlessness of the patient.

Hæmorrhages from the mucous membranes, hæmoptysis, gingivitis, hæmatoma, menorrhagia, and epistaxis may occur, and occasionally purpuric blotches in the skin. Such cases are grave, the bleeding arising from disorganisation of the blood.

Thrombosis may occur in the heart, veins, or arteries. Intracardiac thrombosis may cause sudden death, and is a not uncommon source of infarcts in the viscera (Keen).

Venous Thrombosis is not uncommon during convalescence, most often in the veins of the left lower limb, especially of the calf. Typhoid bacilli have been found in the walls of the vein and in the clot, and probably cause the thrombosis, but it is predisposed to by the feebleness of circulation during convalescence, and occurs mostly in cases which are not very severe, but in which a slight persistent pyrexia delays an increase of patient's diet. The symptoms are the same as thrombosis produces apart from typhoid fever, and usually gradually clear up, but the clot may spread up into large veins, even up the inferior venacava. Death may result from pulmonary embolism or pyrexia. Occasionally several attacks of thrombosis occur each with rigors, great pyrexia, and profuse sweats.

Thrombosis may occur in the intracranial veins.

Occlusion of arteries is much less common than once thought. Keen collected records of forty-six cases, Ferard and Arden twenty-three and seventeen others respectively. Six cases have occurred in my own observation. The obstruction is sometimes from thrombosis, sometimes embolic. Bacilli have been found in the clot and in the arterial wall, and thrombosis appears due in most cases to bacillary invasion of the arterial wall. The arteries of the lower limb are those most often affected. It is manifested by sudden pain in the limb, with lessened or no pulsation in the distal part arteries, coldness, or in some cases rise of temperature, in the local tenderness of the artery at the seat of occlusion, and sometimes loss of power in the limb; also pyrexia, or sudden increase of previous pyrexia. It occurs most often in the third week of the disease, but may be as late as the seventh week. It may entirely clear up, or the limb may remain weak and swelled for months after, or gangrene may result, usually dry (unless both vein and artery are occluded), and death may occur, or recovery after operation.

Gangrene has occurred in the feet, ears, labia, penis, cornea, etc.

Thrombosis may occur in the cerebral arteries and produce convulsions or paralysis.

Respiratory System.—*Lobar pneumonia* may occur at various periods in the disease. In a few cases it has been proved due to the bacillus typhosus.

1. Typhoid fever may begin with the symptoms and signs of acute lobar pneumonia (the initial rigor and rusty sputa are not always present), which quite obscure all other evidences of typhoid fever. After about six days the pneumonia subsides by lysis or by crisis, but the temperature immediately rises again, and there become manifest other and more usual symptoms of typhoid fever, which runs through its usual course. The term pneumo-typhoid has been applied to these cases, but it is seldom that the pneumonia is proved to have been due to the specific bacillus.

2. An attack of pneumonia may occur ending by crisis, but three or four days later an attack of typhoid may commence and go through its usual course. In such cases there is probably a simultaneous mixed infection, the pneumonia developing and completing its course before the typhoid, with its longer incubation period, develops.

3. At any time during the course of typhoid fever pneumonia (at apex or base of the lung) may occur as a complication, with well-marked physical signs, and with a considerable increase in the previous pyrexia, and may subside by crisis, just as in non-typhoid cases, producing sudden collapse symptoms. After the crisis the temperature of the typhoid reasserts itself, and the latter disease continues its course. Sometimes such an attack of pneumonia may come on just as the typhoid is passing away, constituting, as it were, a relapse.

4. Hypostatic pneumonia of insidious character, with percussion dulness and fine true crepitations, but without tubular breathing, may come on at any time in typhoid, most usually in late stages, and may gradually invade increasing portions of lung or lungs. Such cases are probably septic in origin, and are very fatal.

Bronchitis.—In nearly every case catarrhal sounds are audible in the larger bronchial tubes at the commencement of typhoid fever, and they often persist throughout its course, and are of no serious import. But *acute bronchitis* may occur at any time in the disease. Sometimes it comes on with the invasion, and, with the headache and high fever, simulates acute tuberculosis. In such cases it usually soon passes off, but when it comes on late in the disease and spreads into the smaller tubes, and is associated with congestion of the lungs, it is a serious complication, and accounts for a good many deaths.

Pleurisy is less common than bronchitis or pneumonia. The typhoid bacillus has been found in the pleura in only a few cases. Typhoid pleurisy may remain "dry" or result in clear or purulent effusion; according to Osler usually the latter when it occurs in convalescence. Empyema may result from abscesses in the lung following pneumonia.

Pulmonary abscesses, sometimes multiple, may result from pneumonia, and may lead to empyema or to pneumothorax.

Broncho-pneumonia was found by Hoffman in 38 of 250 autopsies in typhoid. It comes on usually in the later stages of the disease.

Hæmorrhagic infarctions occur in the lungs, probably arising from detached thrombi in the right heart, and sometimes from septic collections in other organs.

Gangrene of lung may occur as a sequel of pneumonia.

Hæmoptysis may occur with no discoverable lesion post-mortem. It is sometimes part of a general tendency to a hæmorrhage.

Pneumothorax has occurred from pulmonary abscesses, or abscesses behind the larynx bursting into the pleura.

Tubercle and Typhoid Fever were formerly said to be mutually antagonistic, but typhoid may occur in the subject of acute or chronic phthisis; moreover, the latter may first become evident, if not actually develop, during convalescence from typhoid. Typhoid fever is frequently recovered from when it occurs in phthisical patients, but it tends to increase the activity of the tubercular disease.

Laryngeal Complications.—Simple catarrh, with cough and husky voice, is not rare. Ulcers of the larynx, especially about the arytænoids and base or margin of the epiglottis, may occur during convalescence. Hoffner found them in 28 of 250 autopsies of typhoid cases, and they seem more frequent in Germany than in England. Some ulcers of the larynx are due to other pyogenic organisms than the bacillus typhosus, but the latter is sometimes found in them.

Œdema of the glottis may result from ulceration, or perichondritis may do so, with expectoration of pus and parts of the laryngeal cartilages. Abscesses may also form in the subcutaneous tissues outside the larynx.

Paralysis of the vocal cords may occur during convalescence, with loss of voice, or dyspnœa, requiring tracheotomy. It is mostly due to peripheral nerve changes, and is occasionally a part of general peripheral neuritis.

Urino-genital.—Albuminuria, slight in amount and without symptoms, can scarcely be regarded as a complication, nor can the presence of bacilli in the urine in small numbers. But actual nephritis, with hæmaturia and casts, occurs occasionally. And cases are described and termed "nephro-typhoid," in which the disease begins with all the symptoms of a very acute nephritis, followed by other more characteristic signs of typhoid fever. Some such cases have even proved fatal by perforation of the intestine.

Hæmaturia may occur as part of a general hæmorrhagic tendency. In a case of my own it was fatal, and the autopsy showed it to arise from the mucous membrane of the bladder.

In some cases hæmaturia results from renal infarcts, in which are found the specific bacilli.

Cystitis may occur. Sometimes the colon bacillus or the streptococcus pyogenes or the staphylococcus is found in the pus, more often the typhoid bacillus itself; and probably the cystitis is due in such cases to a rapid multiplication of the bacilli in the urinary bladder, no doubt favoured by the difficulty in emptying the bladder, or the actual retention of urine so common in typhoid fever.

Renal abscesses and pyelitis may occur, also orchitis and epidymitis, sometimes going on to suppuration or sloughing of most of the testis; orchitis and parotitis have been observed together.

Ovaritis may occur, and the specific bacillus has been found in some such cases which suppurated.

Nervous System.—As already said, the nervous symptoms simulating meningitis, which come on with a typhoid attack or during its course are usually toxic in origin, and not due to actual inflammation. But actual meningitis may occur in typhoid. It may initiate the disease with severe headache, vomiting, squint retraction of head, etc. Such cases are very rare, still more rarely are they due to the presence of the specific bacillus. They have been spoken of as "cerebral-typhoid." As a complication of typhoid in its later stages meningitis is also very uncommon. It occurred in 11 of 2000 cases at Munich. Sometimes it is started by middle-ear disease. The streptococcus and pneumococcus, rarely the bacillus typhosus, have been found in the meningeal effusion. Meningitis in typhoid produces its usual symptoms, and often hyperpyrexia. Kerniss's sign is useful in the diagnosis. It is quite possible some cases, even of meningitis, may recover, but it has been suggested that those cases which clear up are due to thrombosis of the cerebral vessels.

Hemiplegia, with or without convulsions, may result from thrombosis of cerebral vessels.

Aphasia may be a sequel or a complication, and is usually temporary only; it is said to be commonest in children.

Hysteria may follow typhoid; also a state like *trance.*

Epilepsy.—Typhoid in epileptics runs its usual course; the fits may occur during the illness, more often during convalescence.

Mental Defects.—After the attack the mind may be completely blank of all that occurred during a considerable period of the disease, and may remain so for ever. Sudden acute mania may occur in convalescence; chronic mania, melancholia, general mental weakness, various forms of delusion, may result from typhoid. They usually pass off in weeks or months.

Ocular Complications.—Catarrhal and phlyctenular conjunctivitis are the most common; suppurative keratitis, iritis, or cyclitis are occasional. Double optic neuritis and subsequent atrophy are recorded. Amblyopia has followed severe hæmorrhages, even without any ophthalmoscopic changes.

Keen believes retinal hæmorrhages in typhoid are more common than thought. Cellulitis of orbit and paralysis of the extra-ocular muscles may occur.

Aural.—Otitis media may occur with its usual symptoms; the bacillus typhosus has not been found in connection with it.

Peripheral Neuritis is a not uncommon complication in the late stages, the symptoms had been noticed by many, but it was Nothnagel who first attributed them to peripheral nerve changes. The manifestations of peripheral neuritis in typhoid are sensory rather than motor disturbance, sometimes merely persistent numbness of the upper or lower extremities; in other cases intense, even agonising pains in the area of distribution of the sciatic, peroneal, ulnar, or other nerve.

The numbness or pains may last for weeks, and may be succeeded by anæsthesia, in one case lasting for eight years. Sometimes paralysis and atrophy of muscles occurs, chiefly in the forearms. Contractions may follow: the palate has been paralysed, and the motor and sensory roots of the fifth nerve (Dreschfeld). Laryngeal paralysis may occur, necessitating tracheotomy.

Optic neuritis is excessively rare. Wednenske records a case in which symmetrical gangrene due to degeneration of peripheral nerves occurred after typhoid. It is probably to peripheral neuritis that most cases of *paraplegia* after typhoid are due, but anterior cornual myelitis has been shown by post-mortem examination sometimes to follow typhoid.

"*Typhoid Spine.*"—Severe pain in the spine and the legs, especially on movement, may occur during convalescence; it seems to be a neurosis.

Tender Toes.—The tops and pads of the toes may become intensely sensitive; this passes off in a few days.

Tetany has been recorded.

Hyperpyrexia is very rare in typhoid fever. Of 200 consecutive cases at St. Mary's Hospital it occurred only twice; the same percentage was found by Bryant in 608 cases collected from *Guy's Hospital Reports;* Ord, Osler, Fagge, and the statistics of the Metropolitan Asylums Board all show the rarity of its occurrence. But rare as it is in typhoid fever, it is infinitely rarer as a complication in itself; it is nearly always due to some local affection. In one of my cases pneumonia, in two perforation and peritonitis, in one suppurative meningitis, and in one rupture of the gall-bladder, were found post mortem. It should, then, never be assumed that hyperpyrexia is a complication in itself without a thorough search for some local affection to account for it. This may be of import in treatment, as the cold bath, which is the most efficient means of reducing temperature, might do harm if it were due to perforation or peritonitis; in such cases treatment must be directed to the local condition and the temperature meanwhile lowered by sponging, quinine, etc.

Rigors occasionally inaugurate the disease, and they are not very infrequent in its later stages. They occur from various causes, from peritonitis, with or without perforation of intestine, or from the onset of pneumonia; they occur repeatedly with repeated melæna in some cases, or with indications of thrombosis or embolism of vessels. In some cases they appear due to septic poisoning from insanitary conditions, and cease when the patient is removed to another dwelling, and in many cases they are probably due to septic absorption from some source. They have been attributed to constipation. In many cases they occur with increase of pyrexia which is quite evanescent and without constitutional disturbance; probably in these cases (mostly females) they are due to some slight disturbance acting on a heat regulating centre, which has become unduly sensitive from toxic and febrile changes.

The significance of rigors as regards prognosis is nil; and the prognosis depends not on the rigors but on the gravity or unimportance of their cause.

CUTANEOUS SYSTEM.—*Lineæ* albicantae on the abdominal wall may result from typhoid fever.

Alopecia is common and may not commence till after convalescence; the hair usually grows again.

The undermentioned cutaneous eruptions may occur:—

1. A uniform scarlet-red rash may appear in the early stages of typhoid. It is mostly more marked on the limbs and shoulders than on the trunk, and is apt to form coalescent patches which point to its being an erythema.
2. Typical erythematous large plaques especially on the forearms.
3. *Tâches bleuâtres.*—Large maculae of a purple colour—these are said to be always due to pediculi.
4. Purpura may come on, usually in late stages of severe attacks, but not necessarily.
5. Miliaria and sudamina occur here as they do in other diseases, especially if there be much sweating.
6. A morbilliform rash and urticaria have been observed.

7. Herpes is uncommon, and mostly indicates pneumonia as a complication.

8. Boils or carbuncles may occur during convalescence.

9. Occasionally pus vesicles like varicella or large bullæ.

10. Drug rashes from quinine, antipyrin, sulphonal, trional, etc.

11. Desquamation occasionally follows typhoid fever.

Gangrene may occur from occlusion of veins or arteries as already described, but it may occur without this, or at any rate without blocking of vessels of any but very small size; and is attributed by Keen to stasis of blood in the capillary circulation, perhaps also to fatty degeneration of the smaller arteries. In this way the penis, labia or ear may become gangrenous; it usually comes on in early convalescence, and the pain is not so marked as in embolic gangrene, and a blue line of demarcation soon forms. Some such cases may be of peripheral nerve origin.

Bed-sores may occur, but rarely in well-nursed patients; they may destroy the ligaments of the sacrum and coccyx, and set up spinal meninigitis.

Rupture of muscular fibre has been studied by Zenker. The muscle changes are not peculiar to typhoid fever, being a granular and waxy change, the fibre coming to resemble the flesh of fish; rupture may easily occur from cough or sudden effort. Ecchymoses and hæmatoma may occur, and the latter may suppurate. The muscles which most often rupture are the abdominal muscles, the adductors of the thigh, and, as Hoffman showed, the diaphragm. There may be no symptoms, but sudden intense pain may be set up, and when the abdominal muscles are torn peritonitis may be simulated.

Periostitis and Osteitis may affect any of the bones, most commonly those of the lower limbs, sometimes the lower jaw; abscess may form in the medulla or beneath the periosteum. The streptococcus or staphylococcus is most often found in the pus, but Eberth's bacillus has been discovered in it, even years after the typhoid fever.

Necrosis, usually in the bones of the lower limb, may occur, attributed by Keen to thrombosis of the veins in the cavernous tissue of bones.

Arthritis may occur, sometimes rheumatic, affecting several joints, or septic, with other evidences of pyæmia. It may also arise from spread of osteitis into a joint, and there may be suppuration. Keen describes also a monasthritis most common in the lower limb, especially the hip; it usually arises spontaneously, sometimes from periostitis or osteitis extending into the joint. It comes on during convalescence insidiously with subacute synovitis; it usually subsides, but may go on to extreme distention of the joint and even to dislocation, especially in the hip in children.

Abscesses may form during typhoid fever in any part of the body—in the soft tissues, serous cavities, bones or joints, and even in the thyroid gland. Subphrenic abscess is recorded resulting from typhoid ulcers in the intestine, or from peritonitis or suppuration of mesenteric glands or from cholecystitis. The abscesses are mostly due to other pyogenic organisms than the typhoid bacillus, and in such cases, must be looked on as of septic origin, but in the pus of some abscesses occurring in typhoid fever the specific bacillus may be found, especially in abscesses connected with the bones.

Pyæmia.—Cases of undoubted pyæmia, setting in with rigors, sweats, and other characteristic symptoms occur, and with metastatic abscesses as a result of typhoid. And many of the dangers and complications of the disease are due to pyæmic infection, and not to the typhoid poison.

Marasmus.—Cases occur in which the patient, though taking food well, wastes after typhoid fever from non-assimilation. This is supposed to be due to atrophy of the ileum and the mesenteric glands; the patient may die after some months or live for years in this wasted state.

Obesity sometimes results after typhoid.

Anasarca may occur during typhoid without albuminuria.

Relapse.—Authors differ as to what constitutes a relapse. Murchison insists on a fresh eruption and fresh bout of pyrexia unaccounted for by any local conditions. Osler writes that two of the three symptoms—step-like ascent of temperature, roseola and enlarged spleen—should be present to justify the diagnosis. But there seems no reason to require for a relapse symptoms not considered essential for a primary attack, and just as the latter may occur without roseola, ascertainable enlargement of spleen or step-like pyrexia (or indeed any pyrexia at all), so may the relapse.

A relapse may be manifested by a period of pyrexia with diarrhœa, tympanites, headache, or other grouping of symptoms such as sometimes constitute a primary attack, and the diagnosis of such a relapse is always aided by the fact of its succeeding an attack of typhoid fever.

There is ambiguity also as to the time of occurrence of a relapse. Murchison speaks of it as occurring after convalescence is fully established, but opinions may differ as to what indicates complete convalescence. Osler's dictum that a relapse can only take place after complete defervence must not be taken too strictly if it implies that the temperature has been absolutely normal before it occurs, for what can hardly be denied the name of a true relapse may occur some days after all symptoms of the first attack have subsided, except that the temperature has on some days slightly exceeded the normal. Irvine believed "intercurrent relapses" may occur without any apyretic interval, and Murchison regarded it as possible. It is certain there be no *long* apyretic interval between attack and relapse; cases are recorded after forty-eight hours' interval, and if so why not after twenty-fours hours. And one must admit a relapse may occur *immediately* after the subsidence of the primary attack, but this subsidence must not be judged only by temporary fall in the temperature, a temporary drop of temperature often occurring about the twentieth day with no amelioration of symptoms.

A relapse may be defined as a re-access of continued pyrexia, and of other symptoms of typhoid fever, coming on immediately or some days after the subsidence of the pyrexia and symptoms of the primary attack (or previous relapse).

This definition may perhaps allow some latitude, but not more than the varying phenomena of typhoid and the insufficiency of our knowledge require.

Frequency of Relapse.—Estimates vary from 3 to 18 per cent of cases, partly owing to the discrepancy in what is regarded as a relapse, partly owing to the varying nature of the epidemic. In some years the frequency of relapse is much greater than in others.

Among 6879 cases treated in the hospitals of the Metropolitan Asylums Board the relapses averaged 8 per cent.

Relapse is said to be at least common in children; to be predisposed to by constipation. Early administration of solid food is generally believed to predispose to relapse, and though this is denied, one sees a fresh access of fever, diarrhœa, quick pulse tympanitis, and general symptoms after giving solid food, too often to ascribe to mere coincidence. Such is specially the case where there has been constipation when solids are first started. Chiari suggests dietetic indiscretions may lead to the discharge of specific bacilli from the bile ducts into the intestine. The cold-bath treatment is said to increase the frequency of relapse, but the curious epochs in which relapses become unusually frequent, point strongly to the character of the epidemic exerting an important influence.

Course of the Relapse.—It may begin with all the typical symptoms of typhoid fever, but the temperature more often ascends abruptly than in primary attacks, and rash is less often present, probably because a good many relapses dwindle away by the period at which eruption is due. A relapse may last five days or be long protracted, longer even than the primary attacks; in Murchison's 53 cases the average duration was fifteen days.

The fever and symptoms usually slowly subside, but hæmorrhage or perforation or pneumonia may occur. Flint regarded a relapse as more serious than the primary attack; the contrary is the general experience; often complications which are septic set up pyrexia and simulate relapses.

Period at which Relapse occurs.—An analysis of 53 cases of relapse by Murchison showed the average period of intermission to be just over eleven days.

Cases are recorded of relapse 48 hours after the subsidence of the first attack; probably they may occur immediately after its subsidence. The period of intermission may be, on the other hand, very long; in one of my own cases it was twenty-six days, in another sixty days, and Goltdammer records an interval of ten weeks.

Multiple Relapses.—A second relapse is not very uncommon, and records exist of three, four, or even five relapses; each relapse is usually less severe than the preceding one.

Cause of Relapses.—Autopsies show that during a relapse fresh intestinal disease associated with the original older disease of the intestine. The part of intestine affected in the relapse is higher than that first attack. The mesenteric glands and spleen become enlarged again. The relapse can only be ascribed to re-infection from within, an occurrence conflicting to some degree with the belief that typhoid fever confers immunity against a second attack.

They have been attributed, with considerable reason, to a fresh absorption of toxins from the alimentary canal.

Recrudescences, exacerbations, spurious relapses, intercurrent relapses, are spoken of and much confused together.

A Spurious Relapse is a rise of temperature occurring during convalescence without the symptoms of a true relapse, and is due usually to nervous excitement or fatigue, or some slight local complication acting on a heat-regulating centre which is in a condition easily disturbed from the effects of the attack of typhoid.

An Exacerbation or Recrudescence.—After an improvement in temperature and symptoms, but without a fall of temperature to normal, the temperature ascends again, and the symptoms become more severe and sometimes more so than throughout the attack. Irvine regarded these as genuine relapses, the relapse overlapping the attack, and spoke of them as "intercurrent relapses."

FORMS OF TYPHOID FEVER

The Mild Form.—There is pyrexia, usually commencing gradually and of moderate degree, and the symptoms generally are not severe. It may run a full course of twenty-one to twenty-eight days, or one of only ten or twelve days. The mildest cases are seen in children. It is to be borne in mind that a "mild" may develop into a serious case as it goes on.

The Severe or Grave Form may be severe from various causes: from the height of the fever, the severity of the intestinal lesions and symptoms, or from profound toxic effects, from the gravity of the complications, or from any combination of these causes. The grave form has been subdivided into many varieties—the hæmorrhagic, adynamic, bilious, ataxic, etc.—but however numerous we make these varieties, they will not cover all the combinations of types which occur in practice. Much of the gravity of many cases is due to other micro-organisms than the typhoid bacillus.

The hæmorrhagic form is not often seen now in England, and is characterised by hæmorrhages under the skin, and from mucous membranes. It is a most dangerous type of the disease.

Abortive Form.—Cases beginning gradually or abruptly (Turjensen says usually abruptly) may end prematurely with a gradual or critical fall of temperature at any time after the tenth day. It is said this may occur even earlier than the tenth day, but before this date the characteristic eruption can hardly have appeared, and the diagnosis can scarcely have been a certain one. (It has been said that in these cases the roseolous eruption occurred on the second to fifth day, but more probably the date of commencement of the disease had been determined wrongly.) These abortive attacks of typhoid may be followed by a relapse.

Ambulatory or Latent Form mostly occurs in the labouring classes who continue their occupation in defiance of symptoms throughout the whole course of the disease to recovery, or till some complication, such as melæna or perforation of intestine, compels their giving up. A young man presented himself in my out-patient department, with extreme tremor of lips and limbs, with extremely feeble pulse, and subnormal temperature, but quite clear in mind. For some days he had felt weak, and on the previous night he had been delirious. He died in the hospital the next morning, the autopsy disclosing typhoid ulcers in the intestines, one of which must have perforated two or three days before death.

Apyrexial Form.—Cases are recorded which have run their whole course to recovery or to death without any pyrexia. Some such cases have been followed by relapses as in other forms of the disease.

Sudoral Type.—Jacqoud has described a form of typhoid under this title, commencing suddenly with severe headache, chills, and sweats; these symptoms may persist a long time, but the disease is usually of a mild type. Jacqoud believes such cases independent of malarial infection.

Typhoid Fever of Non-Enteric Form.—There is no doubt that typhoid fever may occur without any intestinal ulceration, and that the decrease must be regarded as a blood infection with local lesions, of which those in Peyer's glands are the most constant.

As already said, cases of typhoid fever occur commencing with acute pneumonia, or acute nephritis, or acute meningitis, or affections of other internal viscera. In some of these cases the local affection has been demonstrated to be due to the specific bacillus of typhoid, and the term pneumo, or nephro, or cerebral typhoid has been applied to denote such attacks.

Such a nomenclature does not appear necessary or even descriptive of the phenomena that occur, for in such cases the disease does not manifest itself only by these local symptoms, but as they subside, the more characteristic symptoms of typhoid become manifested, such as large spleen diarrhœa and other evidences of intestinal lesions of typhoid fever.

Typhoid Fever in Children.—As mentioned under the head of etiology, the disease is not uncommon even in young children. Of the symptoms of onset, *epistaxis* appears to be less common than in adults, *headache* is nearly always present, marked *somnolence* is more common at the onset than in adults, convulsions and nervous symptoms generally are more prominent, and delirium is often one of the earliest symptoms. It is said, but my own experience is to the contrary, that the temperature usually rises more abruptly than in adults. Its range tends to be higher, and it tends to greater remissions, even intermissions, on each day than it does in adults. The decubitus is often on the side. The disease more often runs a short course than in adults. The splenic enlargement is greater and more easily detectable than in adults, often protruding the abdominal wall. According to Hare, constipation specially occurs in children: this is not the author's experience. The rash is usually slight. Perforation and melœna are less common, but by no means unknown in children's typhoid, and the same is true of septic complications. Emaciation progresses faster in children than in adults.

Pneumo typhoid is certainly commoner in children than adults, so also are joint affections as sequelae, while laryngeal affections are rare.

The prognosis is less grave in children than in adults.

Typhoid Fever in the Aged.—It gets rapidly less common after the age of forty years, but has been seen at the age of seventy-five years. The symptoms are less well marked than in younger persons, and the intestinal lesions probably less severe, but there is a tendency to hypostalic pneumonia, and to asthenia, which renders the prognosis more grave than at an earlier period of life.

Association of Typhoid with other Conditions.—*Pregnancy* confers no immunity. In the early months typhoid usually leads to abortion, but even when the typhoid occurs in the fourth month, pregnancy may go on to full term, and when occurring in the late months it usually does so and the child is born living and healthy. Freund and Levy record a case of spontaneous abortion at the fifth month, and the typhoid bacillus was found in the placenta, and in the spleen and heart of the fœtus. In a case of delivery at the eighth month, the child lived five days, and the bacilli were found in nearly all the viscera. Other similar cases are on record.

Lactation.—In a case of my own, a mother suckled her infant through the first twelve days of typhoid without ill result to the child.

Other Exanthemata.—There is no immunity conferred to other exanthema. On the contrary, a patient with any of the exanthema appears to be in a condition particularly susceptible to contract any of the others, and typhoid may be in any of its stages associated with scarlet fever, either coming on first, and the rashes of both being present together. Diphtheria or measles may be contracted by the typhoid patient. Influenza and typhoid are commonly associated.

Surgical Operations and Injuries.—I have noticed typhoid fever in such cases too often to account for by mere coincidence.

Diagnosis.—The most characteristic evidences of typhoid fever—the roseolous eruption, the tympanites, the recognisable enlargement of spleen, and Vidal's reaction, are not available for diagnosis till after about eight or ten days of the disease have elapsed; the diagnosis at that period is seldom a matter of difficulty, the gradual establishment of a persistent continued pyrexia with the above indications being all that is required.

But the diagnosis is often important at an earlier period than this. It must then be based on the step-like ascent of pyrexia, the headache, epistaxis, and looseness of bowels with moist sounds audible in the bronchial tubes, a dicrotic pulse, and the smell of the breath. Some of these symptoms may be wanting. The temperature chart from the commencement of the disease may not be forthcoming, and even if it is available, the pyrexia may have begun suddenly, and may, contrary to what is customary, have touched the normal on some of the early days. The bowels too may have been constipated, and epistaxis and headache may not have occurred.

Under such circumstances the diagnosis during the first eight or ten days may be impossible, but continued fever without ascertainable local cause should always raise a suspicion of typhoid fever, especially if inquiry shows other cases to have occurred recently in the locality.

The differential diagnosis from the several conditions most simulating typhoid fever must be discussed seriatim.

From Influenza.—Both diseases may begin with headache, pyrexia, and epistaxis. The suddenness of onset, the rapid ascent of temperature, the pain in the back, and the great prostration, usually suffice to distinguish influenza from typhoid fever. But typhoid may begin as abruptly as a typical influenza, and influenza on the other hand may come on as gradually as a typical typhoid attack, with gradually ascending pyrexia, headache, furred tongue, disturbed bowels, and bronchial catarrh. In such cases the diagnosis rests upon the enlargement of spleen, the dicrotic character of the pulse, the roseolous eruption, and Vidal's reaction in typhoid, but it is sometimes impossible to make the differential diagnosis on these grounds without waiting eight or ten days.

The mere persistence of continued fever for many days makes typhoid more probable than influenza, but is not an absolute sign, for the pyrexia of the latter may last for weeks.

Both typhoid and influenza may begin with symptoms of meningitis or encephalitis, and the differential diagnosis rests on the Vidal reaction and the appearance of the cutaneous eruption.

From Pneumonia.—The rigor, abrupt onset, great dyspnœa, rusty sputa, and the physical signs usually serve to distinguish pneumonia from typhoid, but pneumonia may come on gradually after a few days of "cold" or catarrh, and the physical signs may be late in developing. The occurrence of herpes and the ultimate development of the physical signs of pneumonia, and the Vidal reaction in typhoid will usually enable the diagnosis to be made in such cases.

A more common difficulty is to decide whether an undoubted pneumonia is the primary disease or whether it is only a part of typhoid fever; the diagnosis of such cases is often impossible until some days have elapsed, when other symptoms of typhoid fever may appear.

In children especially, "creeping pneumonia" is apt to occur, successive patches of pneumonic consolidation occurring with long protracted pyrexia; this closely resembles a typhoid attack; the diagnosis from typhoid rests then on the course of the pyrexia, the physical signs, the absence of splenic enlargement or of a rash, and the Vidal reaction.

From Tubercular Disease.—Tubercular disease may begin in various ways according to the organs which it mainly affects; it may like typhoid be evidenced for the first few days mainly by pyrexia, with scarcely any sign of visceral lesion; or it may commence with signs of meningitis, closely resembling the onset of those cases known as meningo or cerebro-typhoid; or commencing by pulmonary symptoms it may resemble for a time those cases of typhoid commencing by pneumonia or by severe bronchial catarrh.

Again tubercular disease of the peritoneum may resemble typhoid fever; and data for the differential diagnosis between these various forms of tubercular disease and typhoid fever can only be derived by considering them individually.

Diagnosis between Typhoid and Acute Miliary Tuberculosis.—In both there may be much pyrexia, wasting, diarrhœa, bronchial catarrh, delirium, headache, and abdominal distention.

Typhoid Fever	*Miliary Tuberculosis*
1. Step-like ascent of temperature with subsequent continued pyrexia.	1. Rapid rise of temperature with irregular or regular intermissions or remissions.
2. Cutaneous eruption.	2. No cutaneous eruption.
3. Splenic enlargement.	3. No splenic enlargement.
4. Stools characteristic and usually diarrhœa.	4. Stools not characteristic; often no diarrhœa.
5. No optic neuritis.	5. Optic neuritis common.
6. Rigors.	6. Rigors common.
7. Prostration gradual.	7. Prostration much more than in typhoid.
8. Vidal's test positive.	8. Vidal's test negative.
9. No signs of cranial nerve paralysis.	9. Often signs of cranial nerve paralysis.
10. No tubercle bacilli in sputa.	10. Tubercle bacilli in sputa, if any.

Diagnosis of Cerebral form of Typhoid Fever from Tubercular Meningitis.—In both there occur pyrexia, headache, vomiting.

Typhoid Fever	*Meningitis*
1. Gradual ascent of temperature.	1. Rapid rise of temperature.
2. Generally drowsiness.	2. Generally cerebral irritability.
3. Vomiting rare.	3. Vomiting common.
4. Optic neuritis very rare.	4. Optic neuritis often.
5. Abdomen tumid.	5. Abdomen retracted.
6. Spleen enlarged.	6. Spleen not enlarged.
7. Cutaneous eruption.	7. No cutaneous eruption.
8. Cranial nerve affections very rare	8. Cranial nerve paralysis common.
9. Vidal's test positive.	9. Vidal's test negative.
10. Knee jerk persistent.	10. Knee jerks may disappear and reappear with a few days' interval.
11. No signs of tubercular deposit elsewhere in the body.	11. Often evidences of tubercle in lymphatic glands or lungs, etc.

Diagnosis between Typhoid and Tubercle of Peritoneum.—In both conditions there occur pyrexia, diarrhœa, abdominal distention, and emaciation.

Typhoid Fever	*Tubercle of Peritoneum*
1. Temperature rises gradually and is subsequently of continued type.	1. No step-like ascent of temperature, which is often remittent or intermittent.
2. Splenic enlargement.	2. No splenic enlargement.
3. Cutaneous eruption.	3. No cutaneous eruption.

Typhoid Fever	*Tubercle of Peritoneum*
4. Character of stools distinctive.	4. No distinctive character of stools.
5. Vidal's test affirmative.	5. Vidal's test negative.
6. Local tenderness in right iliac region.	6. Tenderness not limited to right iliac region.
7. No ascites.	7. Often ascites.
8. History of exposure to contagion.	8. Often evidences of tubercle in lymphatic glands, etc.
9. Previous health good.	9. Often precedent loss of flesh.

Diagnosis between Typhoid Fever and Acute Pulmonary Tuberculosis.—In both there occur high fever, cough dyspnœa, expectoration, and the "physical signs" of acute pulmonary catarrh.

Typhoid	*Acute Pulmonary Tuberculosis*
1. There may be step-like ascent of temperature, but often the rise is abrupt.	1. Abrupt rise of temperature.
2. Epistaxis common.	2. Epistaxis absent.
3. Splenic enlargement.	3. No splenic enlargement.
4. Pulse dicrotic.	4. Pulse not dicrotic.
5. Prostration moderate.	5. Prostration severe.
6. Roseolar eruption after tenth day.	6. No roseolar eruption.
7. Vidal's test positive after tenth day.	7. Vidal's test negative.
8. No evidences of consolidation at apices of lungs.	8. Sometimes evidences of apical consolidation.
9. No tubercle bacilli in sputa.	9. Tubercle bacilli in sputa.
10. No evidence of tubercle in body.	10. May be tubercular deposits in glands, etc.

From Typhlitis.—In typhoid fever there usually is typhlitis, and the problem to be solved is not, Is typhlitis present or not, but is the typhlitis present a typhoid or a simple typhlitis?

In typhoid fever constitutional symptoms usually precede the local ones, and the latter are not nearly so severe as in simple typhlitis, there being rarely much pain or vomiting; in typhoid too the stools may be characteristic, and the rise of temperature is gradual and accompanied by headache. The cutaneous eruption of typhoid appears too late to be of use in the diagnosis, and too much stress must not be laid upon it if enemas have been given, as they are capable of producing a similar roseolous eruption.

From Gastro-Enteritis.—Typhoid fever begins sometimes with repeated vomiting, diarrhœa, headache, abdominal pain, and fever simulating and no doubt being associated with gastro-enteritis. The temperature chart, enlargement of spleen, and eventually the rash will clear up the diagnosis, but it is not always possible to diagnose such aberrant cases of typhoid for some days.

From Ulcerative Colitis.—Colonic distention, diarrhœa, melæna and pyrexia occur in both diseases. Colitis is distinguished from typhoid by the absence of skin eruption, of enlarged spleen, of step-like temperature rise, and by the character of the stools, and the pain in the course of the colon or sigmoid flexure.

From Syphilitic Fever.—Secondary or more rarely tertiary syphilis may give rise to persistent, continued (or intermittent) fever with no ascertainable local lesion. When associated with headache and enlarged spleen as it sometimes is, typhoid fever may be closely simulated. When other evidences of typhoid are long absent, and there is a history or evidence of old syphilis, this should be borne in mind.

From Pus Collections in inaccessible Situations.—Pent-up pus may give persistent pyrexia, and when it is so situated that the local signs of its existence are unobtainable typhoid fever may be simulated; especially is this likely to be the case when the abscess is within the abdomen. Thus a right-sided perinephritic abscess in a child produced chills, pyrexia, abdominal swelling, tenderness in the right flank, and was quite impossible to diagnose from typhoid fever till it produced a localised fluctuating swelling. And a duodenal ulcer, with abscess in the liver, produced tension of the abdominal muscles and pain, with chills, continued pyrexia, melæna, and wasting—a combination for a time greatly resembling the symptoms of typhoid fever. Subdiaphragmatic abscess, again, may produce *apparent* enlargement of spleen, with pyrexia and tympanites, resembling an attack of typhoid. And a loculated empyema may do the same.

From Malarial Fever.—The diagnosis is not often required in this country. As a rule the rigors and temperature range serve to distinguish between the two diseases, but cases of malaria occur in which the pyrexia may be nearly continuous, rigors absent, and diarrhœa present. This combination of continued pyrexia with enlarged spleen and diarrhœa greatly simulates typhoid, from which it can only be distinguished by examination of the blood for malarial parasite, or by the appearance of the typhoid roseola.

From Pyæmia and Ulcerative Endocarditis.—These may give pyrexia and enlargement of spleen and pink cutaneous spots. The irregularity of the pyrexia, the absence of the characteristic stools, Vidal's reaction, and, in the case of ulcerative endocarditis, the production of cardiac bruits will assist in diagnosis.

PROGNOSIS.—The fatality of typhoid fever is very variously stated by different authors, and it depends greatly on the character of the epidemic, the age of the patient, and the conditions under which he is placed. Thus in military campaigns the mortality is usually high. Again, percentage mortality varies with the inclusion or exclusion from statistics of those numerous cases of continued fever which cannot with certainty be diagnosed as typhoid. Under the cold bath treatment the mortality is 8 or 9 per cent. In the Maidstone epidemic it was only 7·5 per cent. Hare of Philadelphia estimates it as 10 per cent.

By far the largest body of statistics available are those from the returns of the hospitals under the Metropolitan Asylums Board of London, and the returns of the Registrar-General.

In the former, of 13,552 cases treated from 1871 to 1899 inclusive, 2331 died, a mortality of 17·2 per cent, and of 35,442 cases notified to the Registrar-General as occurring in London during the ten years 1891 to 1900 there were 6011 deaths, a mortality of 16·9 per cent.

This may be taken as the average mortality of typhoid fever in London, and it stands at much the same point as it was computed to stand by Murchison thirty years ago. It must be remembered that a case, however slight it may at first appear, may become serious from toxic effects, or from perforation or melæna.

Age.—The chances of recovery are generally admitted to be greater in children than in adults, but they may have the disease severely, and are not exempt from any of its dangers. Griesinger thinks the prognosis bad in very young children.

Sex.—Is rather more favourable in males than in females.

Obesity is unfavourable.

Idiosyncrasy has probably much to do with the severity of the attack, as it has in the exanthemata generally, some families and some individuals being predisposed to contract and to suffer severely from typhoid.

Season of the Year.—Dreschfield regards it as most fatal in the warm months.

Epidemic Character.—The mortality is great in certain localities and in certain epidemics. Murchison points out the resemblance cases occurring in the same house bear to one another. Surrounding insanitary conditions gravely affect the prognosis.

Previous Health.—Robustness of health confers no immunity or exemption from the chief dangers of the disease, but visceral disease, or diabetes, or privation, affects the prognosis very unfavourably.

Early Treatment.—The prognosis becomes unfavourable the longer the taking to bed is resisted. Moving the patient from the place where he has been lying ill to hospital, etc., is prejudicial in late stages of the disease, but may be less so than stopping in an insanitary dwelling.

Cutaneous Eruption.—There is no relationship between the amount of rash and the severity of the disease. Still, where profuse eruption repeatedly recurs the prognosis is less favourable than where the eruption is shortlived and slight.

Profuse sweating does not affect the prognosis.

Spleen.—There is no relationship between the degree of enlargement of the spleen and the severity of the attack.

Vomiting at the onset of the disease does not affect the prognosis. Coming on late in the disease it is unfavourable, often indicating peritonitis, perforation, or other local lesion or renal failure.

Condition of the Bowels.—Where there is deep ulceration there is generally severe diarrhœa, and though the converse is not the case, there is a general agreement that cases with severe diarrhœa are less favourable than those with constipation. Diarrhœa is especially bad when it comes on late in the disease, and at all times it tends to dry up the tongue and to drain the tissues of fluid. It also prevents the absorption of nutriment from the alimentary canal, and contributes to exhaustion. The best indication of commencing convalescence is the passing of "formed" motions.

Melæna.—Though no amount of melæna renders recovery impossible, and Frousseau and others regarded it as a favourable event, when it occurs in any quantity it is a most serious symptom, not only threatening death from loss of blood from one or repeated bleedings, but because it implies deep ulceration, and therefore often the precedent of perforation. Likewise the anæmia it produces increases the tendency to exhaustion and asthenia.

Perforation may be recovered from, as proved by Murchison's cases, where a pin point perforation had all but healed, when erysipelas carried off the patient. But the frequency of such an occurrence must not be estimated by the many reports of cases of recovery from perforation inferred from symptoms compatible with it. Other conditions produce similar symptoms as operative procedure has several times conclusively proved. And though it is possible a pin point perforation, with but little oozing of intestinal contents, may be recovered from, it is almost certain that any case of perforation with evidences sufficient to diagnose it will allow escape of intestinal contents, and that fatal peritonitis will ensue.

Tympanites.—Sudden supervention of marked tympanites is of bad augury, and great distention is unfavourable under any circumstances; but above all, it is so when the belly is not only distended, but is also soft and doughy, indicating complete loss of nerve tone.

Abdominal pain often indicates *deep* ulceration, especially of the colon, and is unfavourable, and often followed by melæna or perforation.

Incontinence of Fæces is not so grave as it is in other diseases. In them it is usually indicative of profound affection of the nerve centres, but in typhoid local conditions—tympanites, diarrhœa, and the liquidity of the motions—are often the main factors.

Respiratory System.—"Sipping" rapid breathing, with cyanosis and subjective dyspnœa, but without physical signs of lung affection, is of very fatal augury, being due to blood-poisoning. *Pneumonia,* with the ordinary marked physical signs, occurring at the commencement of, or at any time during the attack, is usually recovered from, but pneumonia coming on insidiously, with dulness on percussion, and crepitations, but without tubular breathing, especially on both sides of the chest, is apt to gradually invade increasing portions of lung. It is probably due to septic rather than typhoid infection, and is very fatal.

Acute general bronchitis is a very serious complication. *Pleurisy* is often recovered from if non-suppurative. *Empyema* may result from small abscesses in lung arising from septic pneumonia, and may be recovered from.

Pulse.—Rapidity of pulse is an unfavourable sign; the deaths progressively increasing as the pulse-rate rises over 120 a minute (Murchison). A pulse of 130 per minute is serious, of 140 means grave danger, and a pulse of 150 is rarely recovered from, especially in men. Death may occur when the pulse has never been over 90 a minute. Irregularity or intermittency of pulse is unfavourable, except after the pyrexia has quite subsided, and in children, in whom it is common. The pulse rate is the most important guide we have in the prognosis of typhoid fever.

A persistence of quick pulse though the pyrexia falls foretells a continuance or exacerbation of the disease.

Anæmia.—There is often great emptiness of vessels and want of blood in the late stages, especially of long attacks, and the asthenia resulting from this is of grave import.

Pyrexia.—A temperature of 107° has been recovered from, and cases with normal or subnormal temperature throughout have been fatal; nevertheless, the *temperature range* is to some extent a gauge of the severity of the attack, and a temperature at any time of 105° or over indicates a severe attack. Of cases where the temperature rose to 105·8°, more than half died.

A persistent high temperature without some amount of remission each day is less favourable than where remission occurs, and a well-marked remission each day of 2° is a good omen; but *irregular* sudden rises and falls are of exceedingly bad omen, indicating either local complications or absorption of septic matter, or that the heat-regulating centres are so profoundly affected by toxic influences that they are thrown out of gear. A sudden fall may indicate intestinal hæmorrhage (though the actual discharge of blood per rectum may be delayed some hours), or it may indicate perforation or the crisis of an intercurrent pneumonia. A sudden rise may be produced by the supervention of lobar pneumonia or of peritonitis.

A slight fall in temperature when the rash comes out is favourable and often persists.

A high temperature of 105° is much less serious when it occurs early in the disease than late.

A temperature is often raised by retention of urine.

An early tendency to considerable morning remission is favourable.

Persistence or increase of pyrexia after the twenty-first day or thereabouts is unfavourable, and especially if the temperature rise higher than before.

A fall in temperature without a fall in the pulse rate is mostly followed by a rapid re-rise in temperature and increased severity of symptoms.

Obstinate resistance to antipyretic measures indicates usually a severe case. Hyperpyrexia is always grave, but is nearly always due to some local complication or to septicæmia.

Rigors do not affect the gravity of a case in themselves, but when they arise from severe complications or septic absorption, the prognosis is necessarily serious.

Delirium, etc.—Liebermeister found only 3·5 per cent of cases without noteworthy brain symptoms died; 19·8 per cent of cases with mild delirium died, and 70 per cent of those with stupor or coma.

Jenner asserts that 50 per cent of those with severe delirium die. As Hare observes, "much depends on individual tendencies and on the febrile movement, and he adds that the mental state is a fair index of the severity of the malady." But too much reliance must not be placed on this. Severe delirium is often recovered from, and *without other grave symptoms* is not of serious import. And cases may die of asthenia with the mind clear to the end.

Severe tremor was regarded by Jenner as indicative of deep intestinal ulceration; it is also producible by severe toxæmia; in either case it implies gravity of the case.

Albuminuria of more than slight amount is unfavourable, so also is glycosuria. Nephrotyphoid is said to be always serious; the one case observed by the author recovered.

Retention of urine is of little import unless neglected, when toxic symptoms may result from it, which, added to those of typhoid fever generally, may be fatal in effect.

Pregnancy and the Puerperal State.—Typhoid in early pregnancy usually leads to abortion, but after the sixth month pregnancy usually continues if the typhoid is recovered from. Pregnancy adds to the danger of the patient, but the author's experience agrees with that of Murchison that it is a less serious complication than might be imagined; in the early months abortion is often recovered from, and in the late months pregnancy continues and the child is born alive. The specific bacilli have been found in the fœtus. In the puerperal state the fatality is ·50 per cent.

Hæmorrhage.—Epistaxis in the early stage is not unfavourable, but, coming on late, it or any other hæmorrhage (apart from melæna) indicates grave blood deterioration and a severe type of case.

It has been suggested that the prognosis may be based on the intensity or reverse of Widal's serum reaction, but this is not practicable or of any service.

Toxæmia is one of the chief dangers in typhoid fever. In some cases the well-known signs of the typhoid state terminate in death, but may be recovered from; in other, especially in protracted cases, the tongue does not become dry nor the temperature high, but the patient drifts into a condition of anæmia, great tremulousness, rapid pulse, clammy sweats, sunken belly, and pinched face, with blueness of extremities, the mind remaining clear throughout, or there may be rambling. Such conditions are very unfavourable in prognosis, death occurring from bloodlessness and exhaustion.

Treatment.—Prophylaxis of typhoid fever consists in measures for ensuring the purity of water supply, the perfection of systems of drainage or of other methods of disposal of excreta, and the improvement of sanitary conditions in general, details of which cannot be dealt with here. To the attention given to these points is mainly due the lessened mortality from typhoid fever in England, the returns of the Registrar-General showing a diminution from 390 persons in each million living in 1869, to 173 per million living in 1899.

The *preventative treatment by inoculation* has received extensive trial in the South African campaign, and is said to lessen the susceptibility to the disease and to lighten its severity. Reliable statistics on these points are not available.

In any attack of typhoid fever in a private dwelling (or elsewhere) inquiry should be made as to its sanitary condition, which may, if defective, be prejudicial to recovery and increase the danger of infection of other persons in the house. Defective drains become much more dangerous when a case of typhoid occurs.

The danger of contagion being imparted to others is small if those who attend upon or come in contact with the patient or his excreta be careful to secure ample ventilation, to immediately disinfect all excreta and soiled linen by carbolic acid, and to thoroughly and frequently wash their hands with disinfectants.

In treating typhoid fever it is desirable to know what are its chief dangers. Perforation of intestine causes about 18 per cent, melæna about 15 per cent of the deaths. Other local complications, pneumonia, etc., may bring the deaths from local causes to at the most 50 per cent, so that at least 50 per cent of deaths in typhoid occur from general conditions, asthenia, hyperpyrexia, or by typhoid or other septic poisoning.

It is agreed to by all that the patient with typhoid should keep to bed from the earliest possible moment, and that there shall be no necessity to move from it the use of the bed-pan is necessary. All excreta should be passed into vessels containing disinfectants.

The Diet must be such as will nourish the patient until the disease has run its course, must be easily digestible and assimilable, and such as that little residue shall pass from the stomach. Milk should be the staple article of food, diluted, so as the more to relieve thirst and the less to form solid clot; the diluent may be lime or barley or an aërated water. The quantity of milk should be not less for an adult than two pints in each twenty-four hours; three pints are often well taken. Typhoid patients' appetites and requirements for food vary, and as much milk may be given as the patient can take without producing curds in the stools, or diarrhœa, or distension of stomach or intestines. The milk may be given warm or cold as the patient prefers.

If diluted milk is ill borne it may be peptonised, or tried with the addition of a little tea or coffee. A few patients cannot take milk in any form, and whey, butter-milk, koumiss, or albumen of egg in water may be substituted.

Beef tea and soup, strained clear and free from fat, may be given; ten ounces in twenty-four hours is usually sufficient to supplement the milk, except in cases where the latter is not well taken.

There is no evidence that any of the innumerable artificial foods recommended as superior to milk are preferable to it, and they may be reserved for cases where milk cannot be taken, and for additions to the dietary in early convalescence. No general rule can be laid down for the dieting of those rare cases where cow's milk cannot be taken in any form; they must be treated on the principles adopted in the hand feeding of infants, sometimes substituting for a time real tea or beef-tea or white wine whey. Additions to the diet should not be delayed longer than is necessary, many complications being favoured by debility and feebleness of circulation. On the other hand there is good evidence that too early giving of solid food may set up relapses, or melæna, or perforation. It is possible that solid food may act injuriously by exciting increase of peristalsis, or by fermentation in the intestine lead to fresh absorption of toxins.

It is inadvisable to give solids while the tongue is coated; the converse cannot be said, for the tongue may entirely clean up early in the course of an attack, subsequently proving severe. Nor should solid food be given until the bowels, if constipated, have been well relieved by enemata or otherwise.

The appetite of the patient has been suggested as a guide for his diet, but patients often crave after, and sometimes surreptitiously eat, food which produces very evil results.

The temperature chart is generally taken as a guide to the commencement of solid food; some withold it until seven or even ten days of complete apyrexia have expired; others give solid food without reference to a persistence of pyrexia, often with complete impunity. No doubt in those cases of typhoid in which intestinal ulceration never occurs or is at a minimum, solid food may be given without danger, and even with advantage at a very much earlier period than in other cases in which there has been severe intestinal ulceration. It is not, however, always possible to determine with certainty if ulceration has been slight in an individual case, but where there has been no great tremor, nor melæna, nor much tympanitis, nor diarrhœa, and where the motions become "formed" early, ulceration of intestines has probably been slight, and solid food may be tried early. In cases where there is reason to believe that there has been deep ulceration there is a danger, quite out of proportion to any advantage obtainable, in giving solid food before pyrexia has subsided for at least three complete successive days.

Bread and milk, fish, minced chicken, vegetables, may be gradually added to the diet, and persisted in even if a slight rise of temperature occurs, so long as there is no diarrhœa or tympanites set up, or acceleration of pulse.

Great Thirst may be appeased by drinking cold water or toast water in moderate quantities; large hot-water enemata are also very useful. Saline enemata increase the thirst.

Alcohol is not required in cases of typhoid which progress well, but patients exhausted by combating the disease without taking to bed often require it as soon as they come under treatment. During convalescence a little alcohol is often useful. The general rules which are guides to administration of alcohol in other diseases are applicable in typhoid fever, a dry brown tongue, muttering delirium, failing pulse, and weak heart sounds indicating its administration, but it should not be given more freely than is absolutely required.

Diffusible Stimulants.—Ether, ammonia, sumbul, and black coffee are often useful, and *strychnine* hypodermically administered is of great use when the heart is acting feebly or the nervous system much depressed. Caffein is also useful, especially combined with strychnine.

The Antiseptic Treatment is based on the endeavour to lessen the virulence of the toxins in the intestine before absorption, and to limit the action of the micro-organisms in the alimentary canal. It has been claimed also that antiseptics may *abort* the disease, but this is not substantiated. The antiseptics which have been advocated are innumerable. Charcoal was used by Sir W. Jenner, but is bulky to take; salol is one of the best intestinal antiseptics. B. naphthol is equally useful. The internal use of mercury in typhoid fever was condemned by Murchison, but has been recommended by Broadbent, and the author's experience agrees with his, that it often lessens tympanitis, lowers the pyrexia, and appears to lessen the toxæmic symptoms. It may be given as bichloride grain $\frac{1}{16}$ ter die or as calomel in $\frac{1}{4}$ grain doses. If there is constipation, the calomel is often useful as a laxative as well as an antiseptic. The bichloride is best abstained from when there is melæna. Burney Yeo advocates the internal administration of chlorine water. The carbolic acid treatment readily produces carboluria.

During convalescence the patient should be given as strengthening a diet as he can take, and some alcohol is useful as well as dilute acids and bitters. He should sit up in bed as soon as he can do so without becoming tired, and get up when strength allows. It must always be remembered relapses may occur, and, when they commence, liquid food should be at once returned to. As early as possible the patient should be got into fresh air.

Antitoxin Treatment.—An anti-typhoid serum has been used, but is not of any proved efficiency.

Diarrhœa.—Measures should always be taken to check diarrhœa if the motions are more than two (some say more than four or even eight) in twenty-four hours. Diarrhœa is often due to milk being given too freely or in an unsuitable manner, and lessening the quantity or giving smaller quantities more frequently, or changing the diluent will terminate the diarrhœa; sometimes beef-tea, etc., has to take the place of milk for a time. If changes in diet are not effective, nothing is so useful as an enema of starch with five to ten minims of laudanum. The drugs ordinarily used in diarrhœa are of service in typhoid; salicylate of bismuth in twenty grain doses, with or without a small quantity of Dover's powder, is very efficacious. Intestinal antiseptics sometimes relieve diarrhœa.

Constipation.—Some consider a purge, or a series of purges of calomel to be useful at the commencement of the disease, and a purge is often given before the diagnosis has been made, and appears to do no harm, but there is no reliable evidence that they do any good. Later on purgatives may do serious harm, and constipation must be dealt with by simple enemata, and it is well to add to them some disinfectant, such as sanitas. During convalescence, belladonna and aloes in pill is a useful laxative.

Peritonitis, from any cause except perforation, is best treated by opium, and possibly, even when not due to perforation, laparotomy would offer the best chance of recovery.

Vomiting may be due to uræmia or to some local abdominal complication, peritonitis, etc. When not due to these it may be treated as is usual in other conditions.

Tympanitis may be often lessened by attention to the quantity or character of the diet; apart from this, hot fomentations with turpentine or belladonna are the best means of lessening it. Oil of turpentine enemata are recommended by Murchison, or ten minim doses of oil turpentine by the mouth. Some adopt the ice poultice on the abdomen. The insertion of a hollow tube into the rectum, with attached drainage tube passing into a bucket of water, often allows the escape of flatus, but is apt to lead to urinary retention.

Pain in Abdomen is best treated by fomentations with opium.

Perforation is so rarely spontaneously recovered from that operation affords the best chance of recovery; the difficulty rests in deciding if perforation has occurred; in many cases operation has been performed for perforation when the symptoms resulted from some other cause, and in many other cases perforation occurs with scarcely any symptoms to indicate it.

Melæna.—Opium should be given (in pills, if such can be swallowed), and pushed to the point of contracting the pupils; tincture of hamamelis in 5 minim doses every hour is of great service. Oil of turpentine (a drachm daily in 10 minim doses).

Ergot, gallic acid, and even ergotine seem of little use. The patient must be kept absolutely quiet to lessen the probability of recurrence of bleeding, and the food for the time should be diminished in quantity, but water may be given to allay thirst. The ice bag or ice poultice to the abdomen has some restraining effect in melæna, but must be removed after twenty-four hours, or the tissues become frozen and their vitality impaired. Opium enemata are recommended. Small quantities of alcohol may be required, but not sufficient to excite the heart action.

Often the pulse becomes rapid and full, threatening recurrence of melæna; this is best met by opium.

Murchison strongly recommends the internal administration of spiritus terebinthinæ ♏xv, tinct. opii ♏x, and tannic gr. x, with mucilage every two hours.

Ether subcutaneously may be required after profuse melæna, and if collapse be great, saline intravenous or subcutaneous injections.

Sleeplessness is due often to headache, and ceases when that is relieved. Trional or paraldehyde are good hypnotics; sulphonal takes some hours to act and may produce a rash. Morphia may be given if thought necessary, but once begun will be asked for through the whole course of the disease.

Headache may be best relieved by 3 grains of acetanilid, repeated from time to time.

Delirium requires careful watching of the patient, for he may suddenly get up from bed and catch a chill, or determine hæmorrhage or perforation, or may attempt suicide or injury to others. Low muttering delirium requires alcohol; the liability to it appears lessened by the administration of intestinal antiseptics, commenced early in the case. Restraint of the patient is always to be avoided, if possible, except by having sufficient nurses. When delirium goes on long and there is the condition of incessant wakefulness, a hypodermic injection of morphia is required; trional sometimes acts well. Oxygen inhalations are often useful in toxic delirium, but must not be insisted on if the apparatus excite alarm.

Pyrexia is not now regarded as one of the chief dangers of typhoid fever, and too much importance is not to be attached to the mere temperature; a pyrexia of 103° or even 104° for two or three weeks in a healthy young adult lying in bed and taking food well will not itself produce serious consequences, and when an unusually high temperature occurs, the danger is usually due to the local complication which gives rise to it and not to the pyrexia. And on the other hand serious, even fatal, cases may occur without much or even any pyrexia. The temperature, if judged unduly high for the period of the disease, can usually be temporarily lowered by quinine or by drugs such as phenacetin, antipyrin, acetanilid, etc., but it is not advisable to use any of the latter for this purpose, as they have destructive influences on blood constituents and are depressing. Quinine in 5 grain doses is tonic in effect and is very effective, but it is slow in action. Much the most effective method of reducing pyrexia is the application of water at a low temperature. The simplest plan, and one which is sufficient in most cases, is tepid sponging.

But the cold pack or cold bath has a more powerful effect in reducing the temperature. The cold bath treatment consists in repeated immersions of the patient from the beginning of the disease in water at a temperature of from 65° to 70° or 80° F. Cases of typhoid vary very much in severity in different epidemics, in different countries, and at different ages of life; moreover, at the early stage of the fever at which the cold bath treatment is commenced by some, the diagnosis is so uncertain that some of the cases said to be aborted by the bath treatment may not have been typhoid at all. Still the statistics show the mortality under this method of treatment to be only 8 or 9 per cent, very much less than the mortality in England of about 17 per cent. The mortality in the Maidstone epidemic was only 8 per cent without cold baths.

In the routine treatment all patients must commence it from the earliest period of the disease. Out of every 100 cases of typhoid, 92 would have recovered without the treatment, and 8 who would have died under any treatment are subjected to it unnecessarily. And it is not that doubts are felt as to the benefits of the treatment, but because of the difficulties in private practice of carrying it out, that the cold bath treatment is not more generally adopted.

It is impossible, it must be conceded, to foretell with certainty whether a given case of typhoid will turn out to be mild throughout its course; still in many cases there are indications that it will be so, and, as the cold bath treatment stands a much better chance of being made use of if it be observed in what class of cases it is most requisite, we reiterate insistence on its necessity in every case.

Osler and Liebermeister only give the baths if the temperature rise over 102·5°, Singensen at over 104°.

Hare of Brisbane finds that the temperature of the bath need not be so low as sometimes recommended; he obtained equally good results with water at 75° or 80° F.

Dr. Barr recommends that the patient be kept in a tank of water, continually changing, for many days, the temperature of the water to be 90° to 98°.

Hyperpyrexia is mostly due to some local complication, and if discovered the treatment of it will be indicated; as a symptom nothing is so effective in its treatment as cold bathing, and quinine may be given also.

Asthenia and Toxæmia are commonly combined. The treatment consists in endeavouring to nourish the patient from the very beginning of the illness, giving as much food as he can assimilate, in preventing losses by hæmorrhages and diarrhœa, and by promoting sleep. In a more advanced stage of the disease, with signs of exhaustion and toxæmia, every endeavour must be made to promote the action of the eliminating organs and to stimulate the circulation by strychnine, alcohol, sumbul, musk, and other diffusible stimulants, etc. It is in the reduction of the deaths from asthenia that the routine cold bath treatment lessens the mortality, and not from lessening the frequency of local "accidents." Many of the deaths appear to be contributed to by an actual want of blood, the vessels being empty, and a tendency arising for blood to accumulate in the *venous* circulation.

In these cases intravenous saline injections are sometimes useful, too often only temporarily. I have found they act better at a temperature of 100° than at the higher temperature at which they are sometimes given.

Iron and feeding to the utmost possible are advisable at this period, and I have given bone medulla internally with apparent advantage.

Typhus Fever.

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SYN.—*French,* Typhus exanthématique ; *German,* Fleckfieber.

DEFINITION.—An acute specific infectious fever, prevailing in epidemics, and usually associated with conditions of overcrowding and destitution. Characterised by a sudden onset, a petechial rash, marked nervous symptoms, with great mental confusion and physical prostration, and by a rapid defervescence on or about the fourteenth day.

HISTORY.—Typhus fever is a disease of great antiquity. Murchison has identified with it the pestilence at Athens, so graphically described by Thucydides. From that time onward we have abundant evidence of its frequent epidemic prevalence, and of the severe mortality caused by it. In the sixteenth century the descriptions of the fever stand out more clearly ; Fracastorius, for instance, in 1528, describing it wonderfully accurately under the title of "Febris pestilens." Under this name it was common during the seventeenth century, and was particularly fatal during the Thirty Years' War, the camps of those days lending themselves especially to its propagation. It was apparently common in Great Britain,—the "black assizes," where judges, jurymen, and spectators all sickened, being undoubtedly due to its contagion. Later, the armies during the Napoleonic wars suffered severely from its ravages, and, so recently as in the Crimean campaign, French and English alike lost heavily by typhus.

During the nineteenth century there were several great epidemics in Great Britain and Ireland. They mainly appeared at periods when destitution and famine had lowered the resistance of the population, and they were not infrequently preceded by epidemics of relapsing fever. The disease in many instances appears to have been imported from Ireland to England. Scotland usually suffered markedly, and the fever seems to have persisted there longer than in England. In fact, at the present day, though cases occasionally occur in London, and there has been an outbreak recently in Liverpool, typhus is seldom seen in England, whereas Glasgow usually can show some dozens of cases every year, and the other Scottish large towns have not infrequently small outbreaks. Modern sanitation has taken away all chance of the fever again assuming epidemic proportions in Great Britain, and its interest is now very largely historical. There is no fever, however, which presents a more perfect picture of acute toxæmia ; and it must be remembered that the "typhoid state," that poisoned condition so dreaded in acute disease, derives its name from its resemblance to the normal symptoms of typhus.

ETIOLOGY.—Murchison believed that under certain conditions this fever could originate *de novo.* Such a view is hardly tenable at the present day, and it is almost certain that typhus is caused by a micro-organism, which possibly may require the existence of certain favourable circumstances for its development. Unfortunately up to the present time, although different germs have been discovered by various observers, no proof is forthcoming that any one of them is the true cause of the fever. A diplococcus has been described by Dubief and Bruhl, and another by Balfour and Porter, but the organisms apparently differ in their cultural peculiarities, and inoculation experiments on animals have given negative results.

The most important of the predisposing causes of typhus is undoubtedly *overcrowding.* Whenever large numbers of persons live without sufficient air space, whether in prisons, in ships, in camps, or in the slums of a city, the disease is likely to appear. The names given to it in past times—gaol fever, camp fever, and ship fever—give an idea of the conditions in which it is likely to arise. *Destitution* and *famine* are also given as predisposing causes. The first compels large numbers to crowd in one-roomed dwelling-houses, the second predisposes to the attack of any infection by lowering the resistance of persons exposed, and to this extent their action may be admitted. But typhus often appears in times of comparative prosperity, and overcrowding by itself seems a quite sufficient cause. Again, if half-starved persons lived under favourable sanitary conditions there is no reason to suppose they would contract the disease. As regards age, it has been said that adults are most apt to take the fever, but this is merely because typhus in children is usually mild, and frequently unrecognised; sex exercises no influence. As to climate, the disease is most common in temperate regions. Season has considerable influence, the fever being most common in winter and early spring, the cold causing windows to be shut and thus diminishing the ventilation. Mental and physical fatigue and ill-health may also be regarded as secondary predisposing causes.

DISSEMINATION.—Typhus fever is directly contagious from person to person, and in the vast majority of cases the disease is spread in that manner. Anyone who is in close contact with the sick, a nurse especially, is liable to take it. The poison is apparently carried by the exhalations from the patient, and is no doubt inhaled by the victim. If sufficient attention, however, is paid to the ventilation of the room the risk is reduced to a minimum. Indeed, the germ of typhus would seem to be particularly susceptible to fresh air. In any case the "striking distance" of the disease is an exceedingly short one, the fever in this respect differing markedly from such an infection as small-pox. Absolute contact, or at least entering a small room with no ventilation in which the patient is lying, seems to be necessary for infection. In the last outbreak in Edinburgh it was found that even in crowded and insanitary tenements, only those persons who were on intimate terms with the sufferers, and who were in the habit of entering their apartments, contracted the disease. Others, who were not on familiar terms with them, escaped even though the doors of their rooms opened on the same stuffy and unventilated landing. It has been said that prolonged exposure to the poison even in well-ventilated wards increases the risk of infection. This may well be the case, but is more probably due to increasing fatigue and failure of health on the part of the attendants exposed rather than, as has been suggested, to a gradual concentration of the poison in their systems.

That infection may be retained for long in fomites there is no possible doubt, and those who have to handle the clothes and bedding of the sick, such as laundry-women and public health officials, often contract the fever. Infection seems also to persist long in old houses that have not been thoroughly disinfected or properly aired.

INCUBATION PERIOD.—As a rule this would appear to be about twelve days. In two cases of the writer's, in which there was only one possible exposure, it was exactly thirteen. But shorter incubations are undoubtedly possible. Murchison regards the limits as from a few hours to twenty-one days. The longest incubation in the writer's experience was one of seventeen days at least.

INVASION PERIOD.—This may be said to last from the first symptom of the patient until the temperature reaches the acme, which is usually on the third or fourth day of the fever, and until the appearance of the rash.

The onset of typhus is usually abrupt, the patient being nearly always able to mention definitely the day, and sometimes even the hour at which he first felt ill. The most prominent symptoms are a very marked and persistent feeling of chilliness, causing the sufferer to sit wrapped up in front of the fire, severe headache, pains in the back and limbs, and vomiting. Occasionally there may be actual rigors, and in young children convulsions often occur. The temperature rises, in some cases rapidly, but as a rule slowly and steadily, till by the fourth day of the disease it has attained the acme, usually a point between 102° and 104°. The appetite fails, and the tongue is at first covered with a thin, close-set white fur, which gradually dries and turns yellowish or brown as the disease progresses. Insomnia is common, and even at this early stage the clouding of the intellect, which is such a marked feature of the fever, is frequently present. The patient can seldom keep on his feet beyond the third day of the disease, and takes early to his bed.

THE PERIOD OF ADVANCE.—On the fourth or fifth day of the fever the characteristic *rash* makes its appearance. It consists of small pink spots, a little smaller if anything than the spots of enteric fever. At first they are distinctly raised above the skin, but this is only in the first few hours of their existence. At first, like the enteric spots, they fade on pressure, but afterwards become stained into the skin and persist even if pressed. As the disease progresses they become darker and brownish in colour, and they do not as a rule show much sign of fading before the eleventh day. About that time the rash loses, in many cases, its distinctness; and sometimes all traces of it are gone by the time the crisis is finished. Occasionally a mottled yellowish staining persists. In addition to the spots on the skin there is often, indeed usually, an appearance also of similar spots seen dimly as it were through the skin, the so-called *subcuticular mottling*, seen as a rule best on the flanks. Occasionally this is the only appearance of eruption shown by the patient, and it is quite diagnostic. Lastly, in severe cases true hæmorrhages occur into the skin, appearing as purpuric spots usually small in size, and resembling the marks left by fleabites, except that they lack the central point. This feature of the eruption is responsible for one of the synonyms of the disease, petechial fever. The dark stained, purple to brown, colour of the rash has caused it often to be spoken of as the "mulberry rash of typhus." As a whole, it is fairly distributed over the body except the face. In cases where it is scanty it is best seen on the trunk, and it may be most marked on the back.

The *appearance* of the patient is worthy of attention. The face becomes bloated, the features seem to lose their distinctness, and the expression is that of a drunken man. The eyes are remarkable in that the conjunctivæ are deeply injected and the pupils small, and in severe cases exceedingly contracted. As regards the alimentary system the *tongue* is dry and brown. As the fever goes on it is apt to show transverse fissures and crusts of dried blood and sordes, which may also be seen on the lips and teeth. In severe cases the tongue seems to dry up into a shrivelled black ball, exactly resembling the tongue of a parrot. Vomiting at this stage is not common, but the digestive power is very poor. Constipation is the rule, but occasionally diarrhœa may be severe enough to assume the importance of a complication. The *temperature* remains at a high level, readings of 104° being quite common, and there is little or no morning remission, the chart at first in this stage showing an almost straight line. In cases, however, which are probably running to a favourable termination, there is often a gradual decline of the temperature, sometimes almost imperceptible, in the second week. About the eleventh day there is occasionally a fall of one or two degrees, or even more—a suggestion, as it were, of a false crisis. Hyperpyrexia is uncommon, except in fatal cases when it occasionally immediately precedes death. The *pulse* is accelerated, as a rule, in proportion to the temperature. It usually ranges from 100 to 120, the latter figure being, of course, much exceeded in very bad cases. It has no especial characteristic, and has not the marked dicrotism so common in enteric, but is apt to fail towards the end of the second week. The first sound of the heart as heard at the base soon gets faint, and in bad cases disappears altogether. The *respiration* is invariably rapid, most adult cases breathing 30 to the minute. In the second week of the fever, when there is nearly always more or less hypostatic congestion at the bases, respirations of 40 are quite common. The *urine* nearly always contains albumin, and has the usual characteristics of fever urine, being scanty and high coloured. During the first week the amount of urea is much increased. The so-called diazo reaction of Ehrlich is given by practically every case of typhus at the height of the disease. The *spleen* is invariably much enlarged, often indeed palpable, and this condition is usually appreciable at a much earlier period than is the case in enteric fever.

But it is the *nervous symptoms* of typhus which are the most important and characteristic. The whole nervous system seems thoroughly poisoned. The clouded condition of the mental faculties has given the fever its name. Even the mildest cases suffer from deafness and mental confusion. *Delirium* is almost invariable and is of two kinds—the so-called "delirium ferox," which comes on about the seventh or eight day, when the patient may require several strong men to control him, and has to be strapped to his bed, and more commonly the low, muttering delirium which few patients escape. *Insomnia* sufficiently marked to require treatment occurs in about half the number of adult patients. If the patient is allowed to be sleepless for more than one night the condition may become intractable and may turn the scale against recovery. *Coma* often precedes death, and is usually of the waking variety, the "coma vigil," which must always be regarded as of fatal prognosis. The grave condition of the nervous system is further shown by subsultus of the tendons, and in severe cases by carphology or picking at the bedclothes. Occasionally there is twitching also of the corner of the mouth or of the whole face. The *organic reflexes* are also interfered with. There may be incontinence of both urine and fæces, and frequently the incontinence of urine may be really due to retention, the overflow of a distended bladder escaping into the bed. Even with the most careful nursing bed-sores sometimes occur, the trophic functions of the nervous system suffering with the rest. The headache which was so trying to the patient in the first few days of his illness does not usually trouble him much in the period of advance. It, as a rule, disappears when the delirium begins.

By about the twelfth day of his fever the patient may be regarded as entering the critical stage. He is at this period usually at the very worst. The acute toxæmia and the prolonged and severe pyrexia have thoroughly prostrated him. He lies absolutely helpless, passing his evacuations under him, and usually totally unconscious of his surroundings. The question now is will he recover or not? Fortunately, if he has been judiciously treated and carefully nursed, even when he is looking his very worst, he has still a very fair chance of recovery. But, on the other hand, should he have been over or under stimulated, should he have not been given sufficient sleep, above all, if he has been alcoholic, his chances are very poor. If death supervenes, as in such cases too often occurs, the temperature at this stage of his illness shows signs of rising rather than falling, he may suffer from cold, clammy perspirations, or he may fall into coma before the end comes. In other cases the enfeebled heart cannot stand, as it were, the shock of the crisis, and as the temperature falls the pulse-rate increases, and death occurs with the temperature actually on the normal line.

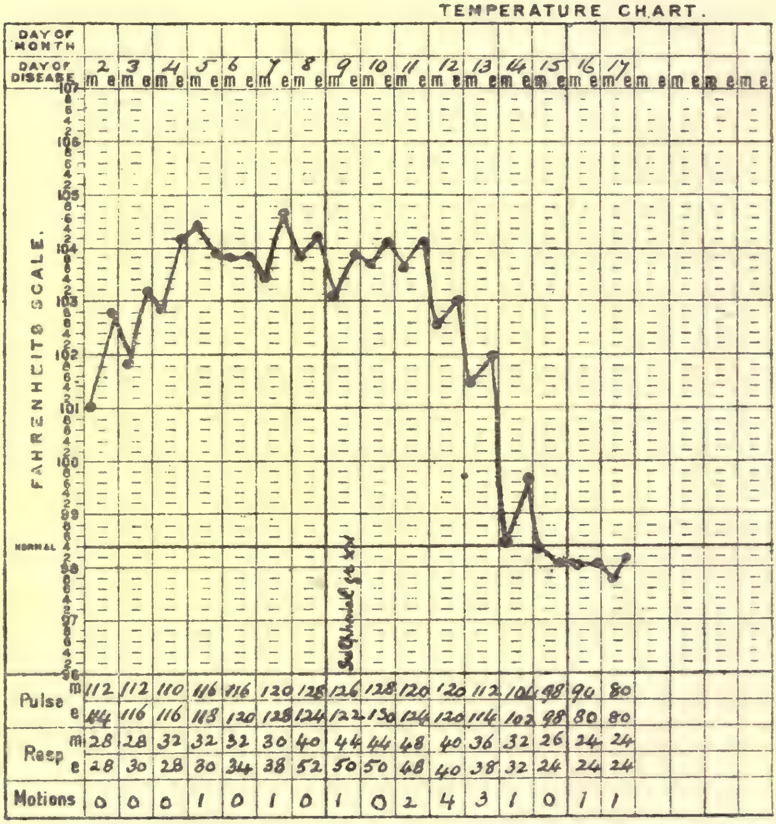
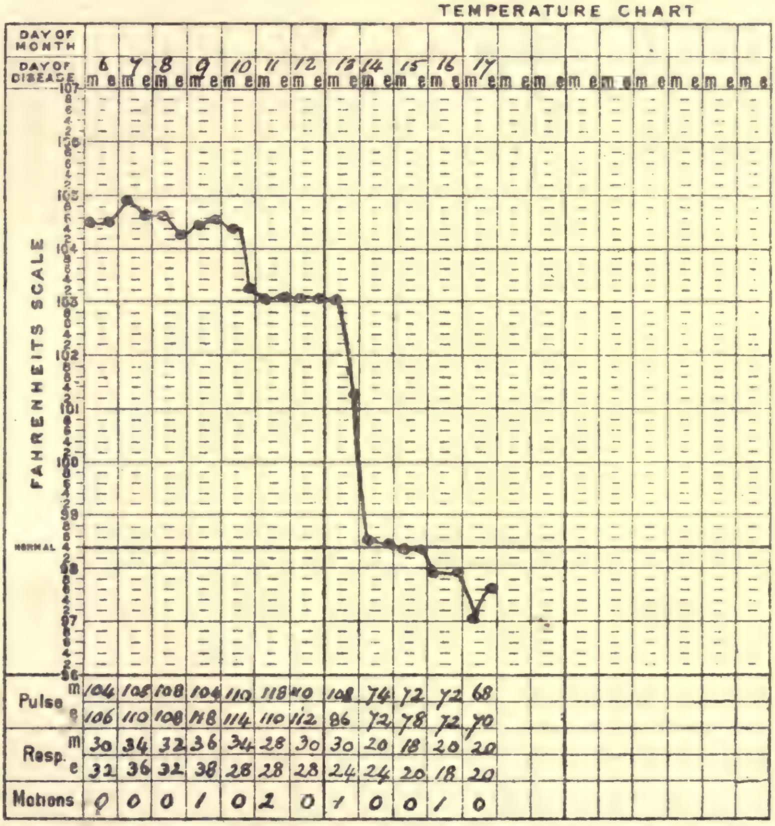


CHART 1.—Chart of a young woman of 23, suffering from severe typhus from second day; recovery. Showing rise of temperature to acme, improvement from 12th day, and final crisis on 14th.

STAGE OF DEFERVESCENCE.—If, on the other hand, as is more often the case, the patient is to progress towards a favourable recovery, the temperature often shows a tendency to fall a little, if only half a degree to a degree, about the twelfth day. The *crisis* itself which follows this slight movement of the temperature is usually a comparatively slow one, but is nevertheless exceedingly well marked. It may commence on the thirteenth, fourteenth, or fifteenth days, or even later, but most commonly a considerable fall is noted on the evening of the thirteenth or the morning of the fourteenth day. The fall may last two or three days, but usually the evening of the fifteenth day sees the temperature normal. Thereafter it tends to remain subnormal for about a week. This gradual but steady abating of the pyrexia is accompanied by a proportionate decrease in the pulse-rate and by a general clearing of the mental confusion. The tongue becomes rapidly moist, the conjunctivæ clear up and lose their pink tinge, and the pupils return to their normal size. The skin is moderately moist, but sweating is unusual and is not a good sign. The urine is much increased in amount and much paler in colour, and the albumin disappears. A slight looseness of the bowels often precedes or accompanies this critical change. Occasionally hypostatic congestion of the lungs may be extensive or severe enough to keep the temperature slightly elevated for some days after the crisis has occurred.



DAY OF DISEASE	6	7	8	9	10	11	12	13	14	15	16	17
Pulse m	104	108	108	104	110	118	110	108	74	72	72	68
Pulse e	106	110	108	118	114	110	112	86	72	78	72	70
Resp. m	30	34	32	36	34	28	30	30	20	18	20	20
Resp. e	32	36	32	38	28	28	28	24	24	20	18	20
Motions	0	0	0	1	0	2	0	1	0	0	1	0

CHART 2.—Man of 26. A mild case of typhus from the sixth day. Showing temperature with slight remission, improvement from 11th day, and a well-marked crisis.

STAGE OF CONVALESCENCE.—Except in a few cases the patient is practically out of danger after his temperature has reached normal. Some patients, however, take a little time to rally after the profound alteration which has occurred in their general condition. The vast majority, fortunately, give no trouble at all, and it is remarkable to see a man, who three days before may have looked absolutely hopeless, eating a liberal allowance of solid food with every sign of enjoyment. Moreover, in spite of considerable wasting having occurred during the fever, the short duration of the disease makes this wasting much less marked than it is in enteric, and convalescence is therefore short. The average patient is well able to be out of bed within a week from his crisis, but it must be, of course, remembered that he is infectious to others for probably a fortnight later. Rare instances of true relapse of typhus have been recorded by Curschmann.

Morbid Anatomy.—A certain number of cases will at a post-mortem examination show traces of the characteristic eruption. The stained spots, of course, are visible after death, and if there has been much true hæmorrhage into the skin the purpuric patches are also visible. Rigor mortis is slight. On opening the body there is nothing to be found which is pathognomonic of the disease. The internal organs are, as a rule, very much congested, and small hæmorrhages may appear on their surfaces, as also occasionally on the lining membrane of the trachea and bronchi. Meningeal hæmorrhages and hyperæmia of the surface of the brain are relatively common. The spleen is much enlarged and usually diffluent. The heart is often dilated, its muscle is flabby and friable, and the blood is very dark and more fluid than normal. Curschmann has noted perichondritis of the arytenoid cartilages with suppuration as occurring comparatively frequently. There is always more or less congestion at the bases of the lungs.

Complications and Sequelæ.—Speaking broadly, typhus is a disease remarkably free from complications. As has been suggested above, the respiratory organs may be occasionally so severely affected that their condition assumes the importance of a complication. Thus the almost constant bronchial catarrh may be very much exaggerated, the laryngitis, not a very infrequent symptom, may be accompanied by severe and fatal ulceration, and occasionally a true croupous pneumonia may appear during or shortly after the fever. Gangrene of the lung has been also reported. Nephritis is occasionally met with both during the disease and in convalescence, and must be regarded as a serious complication, although by no means always fatal. Venous thrombosis or "white leg" has been frequently noted, as is the case in enteric fever, and also the more dangerous condition of arterial embolism. Internal hæmorrhages and passing of blood by the bowel are liable to occur in the more severe hæmorrhagic forms of the fever.

Of the other complications most frequently met with diarrhœa is perhaps the most important. Especially in alcoholic cases this condition, starting at the beginning of the second week, may cause great danger to the patient. Various inflammations are liable to occur in convalescence, the most common being enlargement and suppuration of the parotid gland, suppurative otitis media, and superficial skin abscesses.

Varieties of Typhus.—Numerous variations in the severity and course of the fever have been described. It will be sufficient here to briefly indicate the most important. Certain cases of great severity, the patient being early overwhelmed by the virulence of the poison, have been called "typhus siderans." Other types, where the nervous symptoms or the physical prostration have presented the main feature of the disease, are named "ataxic" and "adynamic" respectively. Cases in which hæmorrhages have occurred into the skin, and from the mucous membranes, are classed as "hæmorrhagic" or "scorbutic." There is also undoubtedly a type which may be termed "abortive," the fever lasting only a week or less. In children, it may be added, the disease usually runs a mild and brief course, and the eruption may be of a fleeting character or altogether absent.

Diagnosis.—In the presence of an epidemic diagnosis is not, as a rule, very difficult. The typically sudden onset of the disease, the early prostration, and the ultimate appearance of the characteristic eruption on or before the fifth day, should not present any difficulty. But it is well to remember that sporadic cases of typhus may occur, and it is very easy to confuse them with other conditions. Again, in children the rash may be very slight and scanty, and the general symptoms of a mild character, and it is sometimes very difficult to come to a satisfactory conclusion. In doing so the general appearance of the patient is of great assistance. Even the mildest cases have usually a flushed and somewhat bloated face, and the conjunctivæ may be said to be always suffused. If a patient with such an aspect has suffered from a sudden attack of chilliness accompanied by headache and vomiting, the presumption in favour of typhus is strong.

Those who have had experience of the fever often find assistance from the characteristic *odour* of the patient. This has been compared to that of rotten straw or of mice, but it really is indescribable. It is usually appreciated only on first lifting or disturbing the bedclothes to look at the rash, and appears to be quite independent of the dirty surroundings in which the typhus patient is usually found, for it has been noted in cases after they have been weeks in hospital. Its existence as a definite sign is, however, it is only fair to add, doubted by no less an authority than Curschmann.

It will be well to consider a few of the chief conditions liable to be mistaken for typhus. In its early stage it closely resembles small-pox in its onset, but this difficulty is so quickly cleared up that it is hardly worth noting. Much more important is its differentiation from the following diseases:—

Typhoid.—This distinction is not likely to cause much difficulty in a patient watched from the first day of his illness. But it is well to remember that all cases of typhoid do not start insidiously, and that in certain instances the onset may be quite abrupt. The difficulty is usually to distinguish a typhus case with a history of some ten days' illness from an enteric case in the third week. The table below gives the chief distinctions:—

	Typhus Fever	Enteric Fever
Face	Congested and bloated.	Pale, with hectic flush.
Expression	Drunken.	Languid and dreamy.
Pupils	Contracted.	Dilated, or in bad cases normal.
Conjunctivæ	Injected.	Clear.
Abdomen	Usually normal and not tender.	Tumid and tender.
Rash	Fairly profuse. Not fading on pressure. Petechial.	Scattered rose spots on trunk, disappearing on pressure.
Pulse	Rapid.	Usually infrequent in comparison to the temperature, and dicrotic.
Termination	Crisis at about end of second week.	Lysis.

It must, however, be always borne in mind that a bad case of enteric, with delirium and a profuse eruption, may defy the skill of the most careful physician. The most reliable method of diagnosis is undoubtedly Widal's reaction, which, if done properly, is absolutely to be trusted. But here, again, the class of persons who contract typhus have often previously had enteric fever, and a reaction may be occasionally given, which is liable to confuse the diagnosis more than ever. Ehrlich's reaction is useless, as all cases of typhus give it.

Pneumonia.—The marked respiratory symptoms of typhus, the flushed face, and the sudden onset have often caused difficulty in distinguishing the two diseases. Moreover, cases of apical pneumonia with "typhoid" symptoms may closely simulate typhus, and the physical signs be not easy to make sure of. In cases where there is doubt in the early stage, before the rash has appeared, it is always well to examine the lungs, and especially the apices, most carefully; and in later stages, where the rash may be presumed to have faded, it is well to ascertain if the dulness at the bases of the lungs is limited to the lower lobes only. A true pneumonia usually affects the whole lobe. A hypostatic pneumonia, complicating typhus, usually affects both sides equally, and may not reach, or may overstep the limits of the lobe. Again, in the latter case, though there may be abundance of fine crepitations, it is unusual to find tubular breathing.

Meningitis.—Here again the absence of the rash is the chief distinction. The typhus patient is hardly so irritable as the meningitic one. If a child, he is not likely to utter the peculiar cerebral cry. He may, however, suffer from ptosis, strabismus, inequality of the pupils, and so on, although these symptoms are, of course, much more common in meningitis. In typhus the headache ceases when the delirium begins, whereas in the severer condition the headache usually persists. The "*tache cérébrale*" may be of some assistance in these cases.

Of the other conditions which may cause confusion we may instance, first, *measles*, the rash of which, when fading, may present a fair imitation of that of typhus. In measles, however, there is always a trace, or a history of the existence of the rash on the face, and usually a history of catarrh of eyes and nose. In typhus the rash never invades the face, and the eyes and nose do not suffer. *Purpura* is usually unaccompanied by fever, and its relatively large hæmorrhages are not seen in conjunction with a subjacent mottled rash. *Uræmia* also is seldom febrile; still, it is well to remember it has been occasionally confused with typhus. *Influenza* in its early stage has may features in common with typhus fever.

Prognosis and Mortality.—Questions of age and sex are of great importance in giving a prognosis. As regards the former, it may be broadly stated that the danger steadily increases as age advances. It has been stated by some observers that the first five years of life show a relatively higher mortality than the subsequent ten, but that is not in accordance with my own experience. The death-rate in persons of under twenty years is almost a negligible quantity, seldom exceeding 3 or 4 per cent. After twenty years have been passed, however, the rate steadily increases, being at least 15 or 20 per cent between the ages of twenty and forty, and nearly 50 per cent when sixty years are passed. As regards sex men are admitted to have a much higher mortality than women. This is no doubt in part due to the greater likelihood that they are alcoholic; but persons of spare constitution, even if alcoholic, of both sexes have a much greater chance of recovery than powerful, muscular, and heavy subjects. The question of body weight is, in my opinion, of considerable importance. A superabundance either of muscle or fat seems distinctly to add to the dangers of the disease.

Every one admits that alcoholism lessens the chance of recovery enormously. The class of persons who usually contract typhus is exceedingly liable to contain a high proportion of alcoholics, and this undoubtedly accounts for the high mortality common in the fever. Such cases suffer from an exaggeration of all the nervous symptoms that have been described above, and it may be said that in ordinary cases the severity is to be chiefly judged by the prominence of the nervous phenomena. Patients who have suffered from true delirium ferox practically never recover. Much muscular twitching, especially of the face, severe tremor, and intractable insomnia, are all symptoms of most evil omen. Coma must be regarded as a prelude to death. Hyperpyrexia, when it occurs, usually also means a fatal termination. Heart failure from toxæmia is usually ushered in by a considerable increase in the rate of the pulse. A rate above 120 is to be regarded as a cause for anxiety; above 130, the patient's condition is most serious. Very rapid respirations, showing a large amount of congestion, or a possible complicating pneumonia, are also a bad sign. Diarrhœa is usually serious, except that looseness of the bowels which so often precedes or accompanies the crisis. Sweating is a particularly ugly symptom.

It may be said roughly that the severity of the disease may be judged by the amount and character of the eruption. Bad cases nearly always have very profuse, dark, and deeply stained eruptions, and much purpuric hæmorrhage. On the other hand, a scanty or transient eruption is usually found in cases of less gravity. A fall of temperature, very slight but comparatively steady from the commencement of the second week towards the time of the true crisis, is of favourable import.

TREATMENT.—In a disease which runs so definite a course it is hardly to be expected that we are likely to find any general treatment likely to check the course of the fever. We are therefore reduced to treating complications as they arise, while at the same time maintaining the strength of the patient to the best of our ability. All agree that typhus cases require a large amount of fresh air. While we are unaware if any experiment in actual open air treatment has yet been attempted, there can be hardly any doubt that some such method will be eventually adopted. In the meantime it will be found useful to keep the temperature of the ward low, and all windows and doors open to the fullest extent. The patient should not be overburdened with bedclothes, a blanket and sheet being amply sufficient covering. Great comfort is given by the use of frequent tepid sponges, and some go so far as to use baths of cold water, as in typhoid fever, as a systematic treatment; but, as in the other fevers, there is little to be gained by direct attempts to lower the temperature. Still more undesirable is the use of antipyretic drugs with that object.

The diet should be light and nourishing. The digestion is practically as weak as it is in typhoid fever, and a milk and beef-tea regimen is to be preferred. To it may be added various meat juices, such as Bovinin, especially valuable when there is diarrhœa and when hot beef-tea is contraindicated. Benger's food, or other similar preparations, plasmon, and an occasional egg-flip, will be found useful in maintaining the strength. It is absolutely necessary that cold water be supplied in abundance. It assists the elimination of toxines and helps to moisten the mouth and tongue. It should be forced upon the patients who are often unable to ask for it. I consider five or six pints a desirable quantity in the twenty-four hours, and I have seen patients drink as much as ten pints with great benefit to themselves. As regards the question of stimulants, it is wise to allow all alcoholic cases a little from the first. Most cases require alcohol in their second week, and it may have to be very freely pushed at the time of the crisis.

As regards the use of drugs when the pulse is failing, the use of many of them will be found disappointing. Strophanthus is occasionally useful, but often fails to make any impression, and strychnine, which is on the whole more reliable, is too apt to increase the ataxic symptoms of the patient. It is, above all, important to secure sufficient sleep for the sufferer, and not more than one sleepless night should be allowed before recourse is had to hypnotics. I have had most success with sulphonal in the early stages of the disease, and later on paraldehyde, given freely. Before drugs are used, however, every device of nursing to induce sleep, sponges, hot drinks, etc., should be tried.

Great attention must be paid to the condition of the mouth, which should be swabbed frequently with boroglyceride or some similar preparation. The skin of the back must be carefully watched, and bed-sores avoided by judicious nursing. The bladder is always a source of anxiety, and should be percussed daily to see that no accumulation of urine is allowed to occur. Constipation, a frequent condition in this fever, should be treated most cautiously. An injudicious dose of castor oil, if given too far on in the fever, may set up an intractable diarrhœa. An enema after the first week is over is much safer. As regards complications they must be treated on general lines.

PROPHYLAXIS.—The general improvement in the sanitary conditions of our great cities has practically removed all chances of a recurrence of the great epidemics of former days. The regulation of common lodging-houses, the abolition of one-roomed dwellings, and the destruction of our worst slums, seem likely to abolish typhus altogether. In presence of an outbreak thorough inspection and disinfection of suspected localities, and a rigid quarantine of all persons exposed to the infection, will soon stamp out the disease. In hospitals the thorough ventilation of the wards, and a liberal allowance of cubic air space per patient, say 2500 to 3000 cubic feet per bed, have been found to protect the attendants on the sick from contracting the fever. The frequent sponging of the patients with antiseptic solutions, such as Jeyes' fluid in water, is probably also of some prophylactic value. It is also important for the physicians and nurses to be in good health, and no one who is at all "run down" or ailing should be permitted to enter a typhus ward.

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